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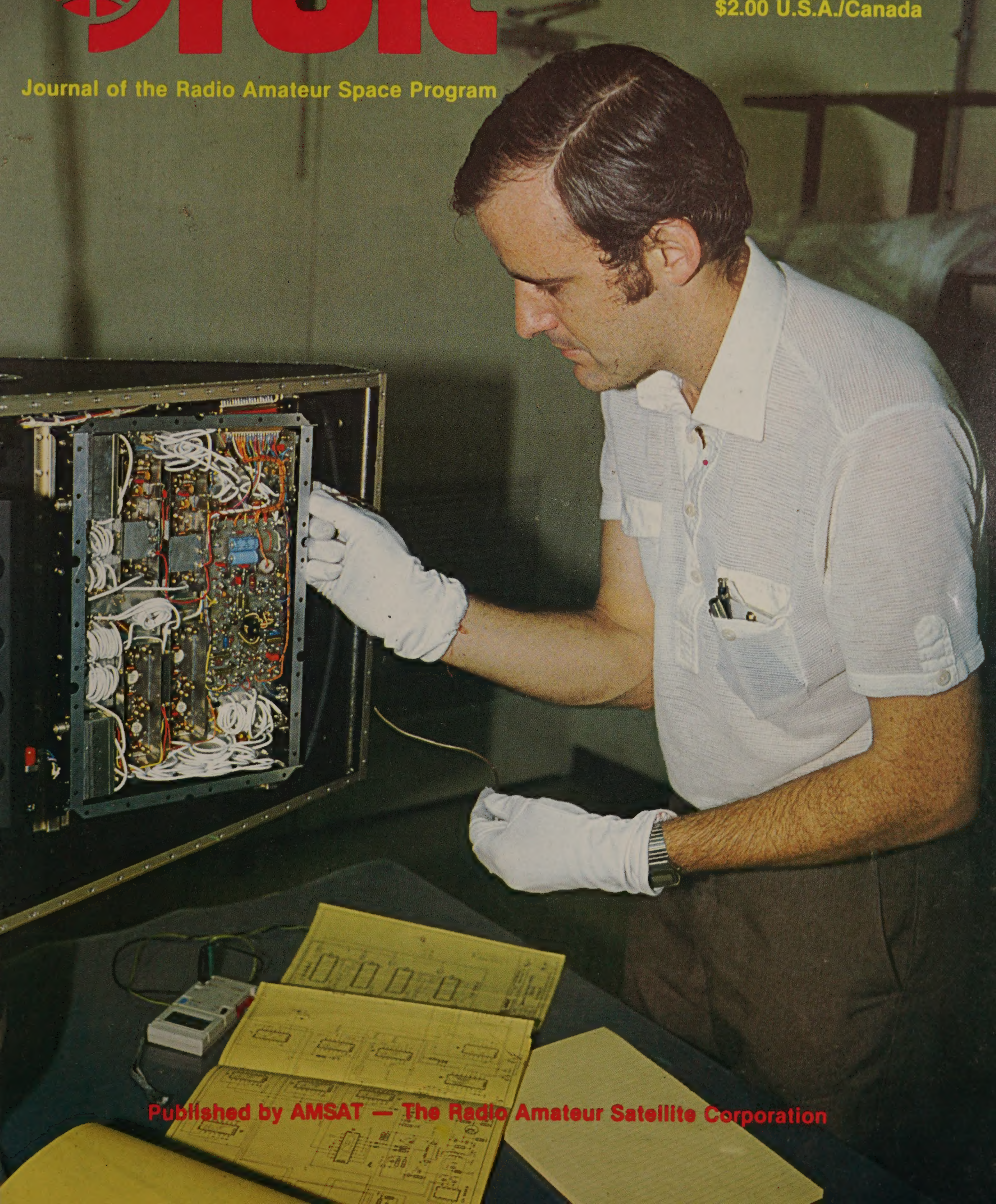

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July/August 1982
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CONTENTS:

Technical Features:

4 Apple II Computer Antenna and Station Control System
By William D. McCaa, K0RZ
Personal computers are quickly taking hold in the Ham Shack. Here we find the personal computer controlling many of the station functions.

8 A 435 MHz Helix for Phase III By Bill Allen, W7US
Another "Twist" on a popular topic: Getting ready for Phase III satellites. Calculations for several versions are given along with a finished model of one.

12. Low-Cost Computer Project By Bob Nickles, KE0T
A special version of the ZX-81 tailored for tracking tasks.

14 An Introduction to Orbit Calculations By Winston Cope
A discussion of how the geometry of orbits is handled in a computer program.

16 Phase IIIB Special Service Channel Utilization
By Richard Zwirko,* K1HTV and Bob Ruedisueli,**W4OWA
Part II of this informative and intriguing discussion of Phase III Special Service Channels. (Part I appeared in ORBIT No. 10)

Informational Topics:

22 The NASA Satellite Tracking and Communications Network
By Jim Lacy
The NASA system for tracking and communications is a worldwide network of hardware, as described here by a twenty-year veteran of public affairs with the space program.

Departments:

3 Ellipsis . . . By Vern Riportella, WA2LQQ

21 AMSAT News

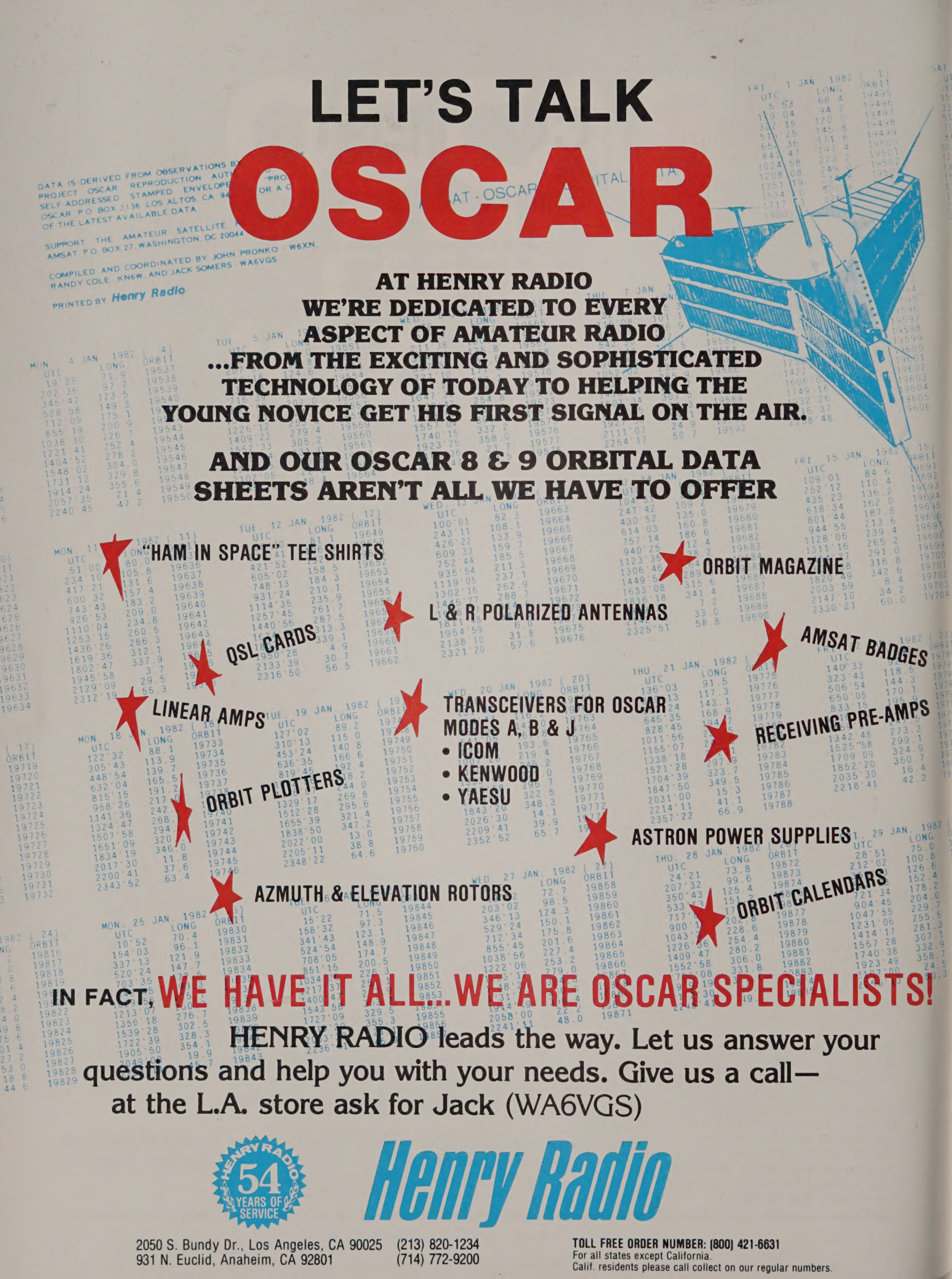
28 Satellite Log By Geoffrey Falworth

10 Worldwide Satellite Activity By Pat Gowen, G3IOR

11 W6 Space Philosopher By John Browning, W6SP

27 Around the World By Kaz Deskur, K2ZRO

Our Cover: Final preparations were under way for test of the Phase IIIB satellite when this photo was taken. Gordon Hardman, KE3D/ZS1FE performs the task with precision.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Ellipsis...

AN EDITORIAL BY VERN RIPORTELLA, WA2LQQ*

Poised as we are on the brink of substantially new ways of communicating with the rest of the world's amateurs, it might be a particularly good time to briefly examine how we got here in the first place. More important even than the lessons of the past, we suspect, are the methods we use to plan for the future. How will they be different as we bridge from Phase II to Phase III and later satellites?

For the last 20 years or so satellites have been "born" mostly of opportunity. Launch opportunity. Given a specific "ride," our people have consistently come up with the resources to build a piece of hardware which made the most of what they had available. Under these circumstances, however, it is difficult to plan for the long term. After all, why should one build an attached garage when it is unsure that the house will be standing when the garage is done?!?

Seen another way, the time between available launches has tended to be similar to the life of the satellites we've built. AMSAT-OSCAR 7 was a notable exception in that it maintained a substantial fraction of its overall mission capability until nearly twice its design life had elapsed. Thus we had at that time the rare pleasure of having TWO OSCARs to enjoy concurrently. Now of course we are immersed in wealth of sorts having (would you believe it?) 7 (or 7½) satellites to enjoy. But still with expected usable lifetime comparable to intervals between launches, it remains difficult to think in terms of multi-satellite systems, system capability and so forth.

In fact, until now we have been building these marvelous little machines one at a time. Given the limited resources, volunteer environment and costs involved we wonder how it could possibly have been done differently. That is, given the terribly risky nature of getting "here" from "there," it is difficult to reckon more than even a few alternate paths to where we now find ourselves. Frankly, we've gotten here by a rare combination of good fortune and the sweat, guts, heartbreak and determination of less than a score of key "doers."

The complexion of our very special hobby will be markedly changed by this time next year. Thousands, perhaps tens of thousands of potential new satellite users will appear all at once on the scene responding to the enormously attractive vistas Phase IIIB will paint. AMSAT leadership has wrestled with the problems perceived in responding to a ponderous growth impulse such as is forecast by some. On the positive side of the forecast growth is the anticipation that with growth will come the resources to change the way we do "business." The planning business, that is.

Thus, as we stand on the brink of Phase III, we bridge two great ages in amateur satellites. Until now we've been treating amateur satellites as if they were experimental. All the OSCARs and RSs which have flown have required special equipment and, more important we suspect, special knowledge and training. Let's face it. OSCAR 8 doesn't come with an automatic transmission. Some folks can't drive stick shift, you know! Our growth has been limited by the nature of folks who want to turn on their radios and have the darn thing there to use...almost like the ionosphere. But Phase III will mark the beginning of amateur satellites as a *utility*. With easier use will come the utilitarians. Their presence in our numbers will allow us to approach the task of planning in new and exciting ways. Moreover, the advent of long-life satellites will prove conducive to thinking in terms of multi-satellite systems; in terms of system capabilities.

Given a steadily growing user base from which to draw resources we can for the first time *afford* to design systems the way they should be designed. In the past the "driver" in system design has been mainly what we could accomplish within certain limited envelopes. First came the basics; the ride itself; where the ride was going and how much weight it could carry determined just about everything in all previous amateur satellite missions. Indeed this overall constraint persists since it largely dictates what will become of Phase IIIB. It will likely affect Phase IIIC also when a ride is confirmed for it. In the future we may be able to specify a long-term goal and then build in the short-term to meet that goal. Perhaps a concrete, familiar example will help to illustrate the idea.

Early in his Presidency, John Kennedy crystalyzed national resolve by setting a long-term, ambitious, imaginative goal: To place a man on the moon in the decade of the Sixties. As we recall it was done in 1969. But to attain that goal required the efforts of millions of individuals, billions of dollars and most of a decade. But in the end it worked. It worked to put a man on the moon. It worked because to reach that lofty goal required the attainment of millions of smaller, intermediate goals.

(Continued on page 7)

Editor-in-Chief, ORBIT *Magazine*

Apple II Computer Antenna and Station Control System

By William D. McCaa, Ph.D.,* K0RZ

Personal Computers are quickly taking hold in the Ham Shack. Here we find the PC controlling major station functions.

The microprocessor control of satellite ground station antenna systems is certainly not a new subject to the amateur satellite user. Over the years, the amateur journals have published numerous technical articles on this subject. However, most of these require that the prospective builder have a good understanding of computer programming, electronic digital circuits, and circuit board construction practices. It is the intent of this article to provide the satellite user who already has an Apple-II Computer a how-to-do-it simply and effectively, without undertaking an extensive construction project and programming effort.

The system as described can be used to perform in *real time* a number of station functions. It can be used to point the antennas, control the station ac power, select the appropriate station transmitter, rf power, and receiver, correct for doppler shift, and do most if not all of the station functions that a satellite user must do while operating a pass. In addition, the software can be prepared so as to provide the operator a *real time* display of the satellite status of several satellites simultaneously, their Reference Crossing, time remaining in the present pass, time to next pass, and antenna pointing data for other ground station locations.

Fig. 1 is a photograph of the CRT display for Boulder, Colorado driven by the Apple-II. The display does not scroll but instead updates a stationary line at a time. It requires about 35 seconds for the entire screen to update. The top line displays the date and time in UTC. The second line indicates that the antenna system is tracking RS-4. Inverted video is displayed whenever the system is locked and tracking a selected satellite. Looking across the fourth through the eleventh line we see the following data displayed for each satellite: the name, the present orbit number, the ground track or sub-satellite point latitude and longitude, the time in minutes to the next acquisition of AO-8, UO-9, RS-6, and RS-3, or if the satellite is in range the time remaining in the pass until loss of signal as is the case for RS-8, RS-4, RS-5, RS-7 and finally the azimuth and elevation to each satellite in range. The bottom set of lines thirteen through twenty display the reference data for each satellite as well as the UTC time of acquisition and loss of each satellite.

General System Configuration

The Apple II computer controls the pointing of satellite antenna systems as well as other station functions automatically thru the use of a Mountain Computer 16 Channel A/D + D/A board and Apple Clock board. The Apple II must be equiped with Applesoft in ROM or a Language System, 48K of RAM, and at least one Disk II drive, as well as the above mentioned Mountain Computer boards. The rotators must be capable of providing a DC voltage proportional to their position and have their brake released during tracking times. The A/D + D/A operates between −5 and +5 VDC and rotators that provide a higher position voltage can be used by dividing the voltage down to the 5 volt level. In addition to the hardware already mentioned the user will have to construct a few simple circuits to enable telling the Apple II what satellite to track, and to allow the Apple II to control the rotators and any other function desired such as powering the station on acquisition of a selected satellite.

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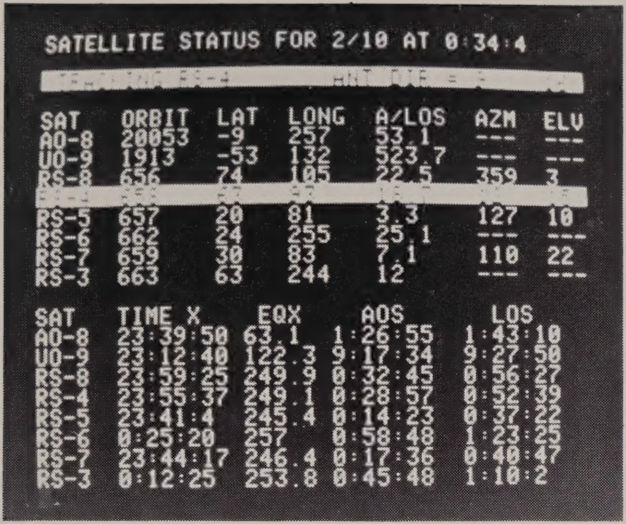
*AMSAT Hq., P.O. Box 27, Washington, DC 20044



```
SATELLITE STATUS FOR 2/10 AT 0:34:4
TRACKING RS-4           ANT DIR = [illegible]
SAT   ORBIT  LAT   LONG   A/LOS   AZM   ELV
AO-8  20053  -9    257    53.1    ---   ---
UO-9  1913   -53   132    523.7   ---   ---
RS-8  656    74    105    22.5    359   3
[illegible]
RS-5  657    20    81     3.3     127   10
RS-6  662    24    255    25.1    ---   ---
RS-7  659    30    83     7.1     110   22
RS-3  663    63    244    12      ---   ---

SAT   TIME X    EQX    AOS      LOS
AO-8  23:39:50 63.1   1:26:55  1:43:10
UO-9  23:12:40 122.3 9:17:34  9:27:50
RS-8  23:59:25 249.9 0:32:45  0:56:27
RS-4  23:55:37 249.1 0:28:57  0:52:39
RS-5  23:41:4  245.4 0:14:23  0:37:22
RS-6  0:25:20  257    0:58:48  1:23:25
RS-7  23:44:17 246.4 0:17:36  0:40:47
RS-3  0:12:25  253.8 0:45:48  1:10:2
```

Fig. 1 — Apple II driver CRT display for Boulder, Colorado.

Software

All software is written in the programming language BASIC. It is hoped that this choice will provide the potential user a better understanding of the programs and to allow for their customizing for use in individual station. It is also hoped that this choice will facilitate the transportability to other computers.

Programming the Apple II to display timely and useful information as shown in Fig. 1, while at the same time controlling the station without the use of 6502 Assembly language requires the extensive use of disk look up files. For operator convenience, the operation program is completely self loading and executing. No data need be input thru the keyboard when running the operation program. Upon execution the operation program reads the disk file containing all the parameters for each satellite. It then obtains the time and date from the Apple Clock and updates the reference data to the present date for each satellite and writes this updated reference data back into the disk file. The program now enters an unending loop where for each satellite in the sequence the display is continuously checked and updated. The loop starts with the reading of the disk file containing the times of acquisition and loss of the satellite for the current orbit. It then calculates the subsatellite point and the antenna heading from the ground station to the satellite. Next a check of the ADC is made to determine if the particular satellite has been selected to be tracked. If it has and the calculated elevation angle is greater than −5 degrees then the rotator position voltages are measured thru the ADC and converted to positional headings and compared with the calculated values for the satellite. If they differ by 5 degrees azimuth or 3 degrees elevation the rotator is activated thru the DAC and the position checked until they fall within the specified tolerance. The tracking display line is then updated and the operation program repeats the cycle for the next satellite in the sequence. Separate utility programs are used to generate enter and maintain the disk file containing the satellite data and the acquisition and loss times.

The programs necessary to perform these tasks are quite extensive, and will not be listed in this article. The programs are available, however, through the *AMSAT Software Exchange*. The programs are all written in Applesoft and operate in conjunction with Disk-II random access text files that contain the satellite reference data, the acquisition and loss time data for each satellite at the latitude and longitude of the user ground station. The operation program will update the satellite data text file to the reference orbit for the present day. The software will allow the operator to select any one of up to 8 satellites for automatic tracking. This limitation is imposed by the character size (40 × 24) of the Apple II screen display. The specific satellite is entered as BCD data into four switch circuits that are wired to the A/D & D/A board as described later. For example, to track the satellite whose data is in the satellite text file at index #6, the switches would be set as follows: #1-OFF, #2-ON, #3-ON, #4-OFF, for the BCD value of 6. Switch #1 has the value of 1 when on, Switch #2 has the value of 2 when on, Switch #3 has the value of 4 when on, and Switch #4 has the value of 8 when on.

There are also four individual control voltages available from the A/D & D/A board for control of the station equipment or any other function that the operator may desire. The voltages are normally set at −5 volts dc until the selected satellite is in range and the antenna system is tracking the satellite. The control voltages that go to +5 volts are the ones that correspond to the switches set to the on position. For example, with the program tracking satellite with the index of *#6*, the voltages would be +5 VDC for Control #2, and Control #3, and −5 VDC for Control #1, and Control #4. The user may choose to ignore the use of these control voltages without suffering any penalty in the operation of the program.

Connection To The A/D & D/A Board

The A/D & D/A board should be in Slot #5 of the Apple II and the Apple Clock in Slot #4. The following are the connector locations of the A/D & D/A board that require connection to the rotators and rotator control circuits as well as to the satellite relection switches and station control circuits.

Connector	Address	Channel	Function
ADC J2-16	49361	1	Read the azimuth voltage from rotator.
ADC J2-15	49362	2	Read the elevation voltage from rotator.
ADC J2-01	49375	15	Read if selector switch #1 is on. Switch #1 carries a BCD value of 1.

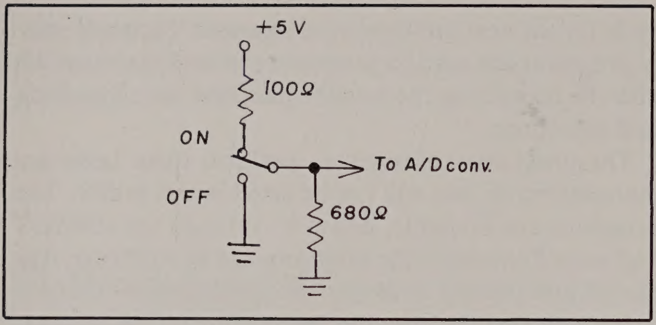


Fig. 2 — Schematic diagram of a switch circuit.

ADC J2-02	49374	14	Read if selector switch #2 is on. Switch #2 carries a BCD value of 2.
ADC J2-03	49373	13	Read if selector switch #3 is on. Switch #3 carries a BCD value of 4.
ADC J2-04	49372	12	Read if selector switch #4 is on. Switch #4 carries a BCD value of 8.
DAC J1-16	49361	1	Activate azimuth rotator clock-Wise. Voltage out is +5 to turn, −5 to stop.
DAC J1-15	49362	2	Activate azimuth rotator counter clock-Wise. Voltage out is +5 to turn, −5 to stop.
DAC J1-13	49363	3	Activate elevation rotator UP. Voltage out is +5 to turn, −5 to stop.
DAC J1-12	49364	4	Activate elevation rotator DOWN. Voltage out is +5 to turn, −5 to stop.
DAC J1-01	49375	15	Station Control #1 follows switch #1. Voltage out is +5 when tracking, −5 volts when inactive.
DAC J1-02	49374	14	Station Control #2, follows switch #2. Voltage out is +5 when tracking, −5 volts when inactive.
DAC J1-03	49373	13	Station Control #3, follows switch #3. Voltage out is +5 when tracking, −5 volts when inactive.
DAC J1-04	49372	12	Station Control #4, follows switch #4. Voltage out is +5 when tracking, −5 volts when inactive.

Fig. 2 is a schematic diagram of one of the switches that drives the ADC for input of the satellite index for tracking. You will need four of these circuits. Fig. 3 is for the control relay that the DAC drives. If all the features of the system are to be used, you will need eight of these circuits. Four for rotor control and four for station control. Fig. 4 is a suggested circuit for connection of the position voltage output from the rotor to the ADC. You will need two of these, each with the resistor values selected for the rotor so as to provide a dc voltage of no more than 5 volts at maximum position. A lower voltage is acceptable but should not be any lower than 1 volt as the position accuracy will be reduced. Note that the source voltage to the position pot in the rotator should be regulated and must remain on throughout the tracking period. Further discussion of interfacing the rotators to the ADC can be found in the excellent article by W6PAJ in reference number 1.

Setup of the Computer Program

After the system is connected, it will be necessary to obtain four voltage readings using the A/D&D/A Board. The four voltages correspond to the following rotator positions:

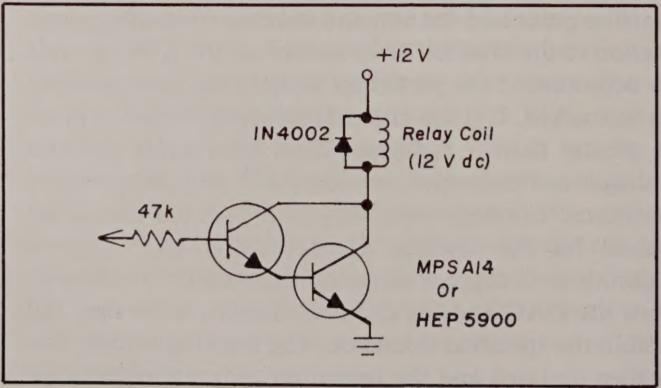
ADC Channel	Address	Designation	Rotor Position
1	49361	AOV	Azimuth rotator at full Counter Clock-Wise position, pointing south, and at the minimum position voltage.
1	49361	AMV	Azimuth rotator at full Clock-Wise Position, pointing south, and at the maximum position voltage.
2	49362	EOV	Elevation rotator at zero degrees, DOWN, and minimum position voltage.
2	49362	EMV	Elevation rotator at 90 degrees, UP, and maximum position voltage.

These four voltage values must be entered into the operating program as position calibration voltages. From this point on you should be enjoying hands free satellite tracking and a new dimension to operating through the satellites.

Future Considerations

The question of using the graphics capabilities of the Apple II has often been raised. This system has been in

Fig. 3 — Circuit diagram of a relay circuit.



operation at the author's station for the past two years. With this experience, the use of graphics is thought to be more decorative than functional in light of the additional execution time to update the graphic screen.

Some thought has been given to using an 80 Character display board for the Apple II. This addition would certainly allow for the system to accommodate the display of additional satellites. Likewise a mixture of the 80 Character board and the graphics of the Apple II could produce some very interesting displays.

To date, all of the programs have been written to accommodate circular orbit satellites reference specification by Equator Crossings and elliptical orbit satellites by Perigee Crossings. Undoubtedly some modifications to the software will be needed to accommodate the working methods for the reference specifications of a Phase IIIB type orbit.

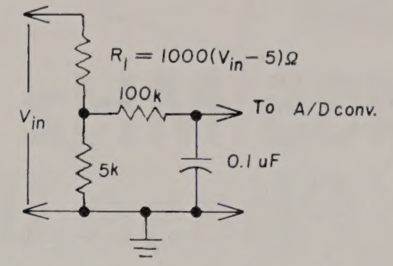


Fig. 4 — Schematic diagram of the voltage divider circuit.

References

1. "Pointing Your Antenna By Computer," Reymann, W6PAJ, *ORBIT*, Vol. 1, No. 4, 1980.
2. AMSAT Software Exchange, P.O. Box 338, Ashmore Il 61912.

Ellipsis...

(The Editorial continues from page 3)

With 30,000 or 40,000 AMSAT members on the team perhaps we too will be able to set a lofty goal...and then work to see it attained by reaching for and attaining numerous smaller, intermediate goals.

Now don't misread us. AMSAT has never been particularly short on "blue-sky-dreamers." And Phase III itself is audacious, bold and imaginative. But we suggest that soon we may be able to approach our goal setting in a manner symbolically similar to that of President Kennedy. We hope it will have similarly galvanizing effects on organizational purpose.

Let us set a goal that will start the adrenalin coursing through the brains and hands of our "doers." Let us dare to dream of systems undreamt. Let us fan the fires of imagination in our present and future user community from where our support must surely come.

Let us set our goal in terms of one simple sentence. So simple that it is never forgotten; so simple that it provides limitless alternate approaches yet is a thread common to most among us now and to many who will shortly join us; as elegant a statement as "putting a man on the moon."

"Amateur satellite communication: anyone, anytime, anywhere, any mode."

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Executive Director/General Manager

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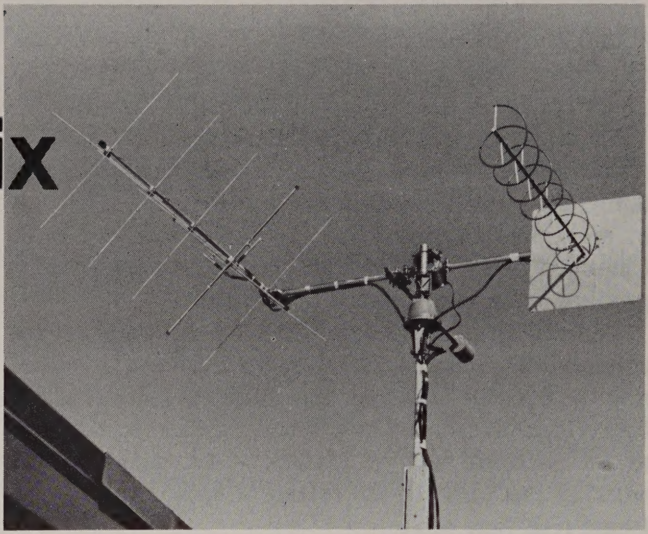
- Lead a comprehensive fund raising activity both inside and outside the Amateur Radio community.

This position is located in suburban, Washington, D.C. and will require some travel and weekend work. Compensation is in the $30,000 per year range, with substantial performance based incentives. An engineering/technical background is desirable. Active Radio Amateur interest is mandatory. Send resumes to: AMSAT Search Committee, P.O. Box 27, Washington, DC 20044. *Deadline is Nov. 1, 1982.*

A 435 MHz Helix for Phase III



By Bill Allen,* W7US

Another "twist" on a favorite topic.

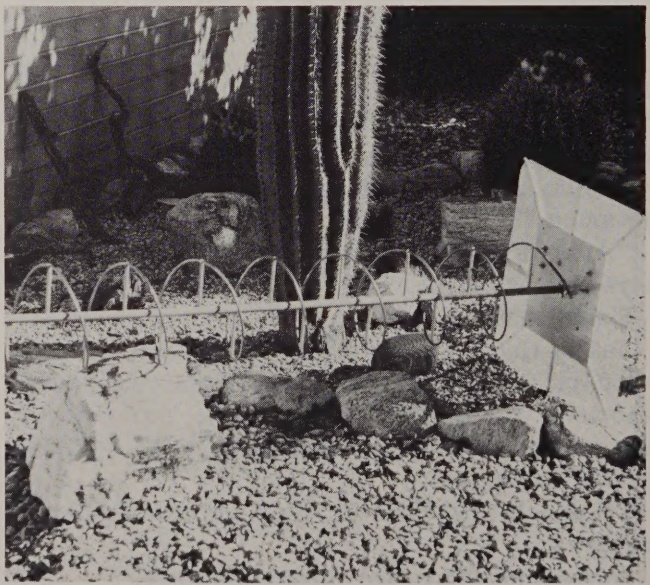
Since the publication of the Mode-J Helix article in the *AMSAT Newsletter* for June, 1979, much interest has been expressed in this kind of antenna. Users have found that the results obtained using this type of antenna in both modes "B" and "J" have been most gratifying. Many reports have been received verifying the excellent performance of this simple antenna.

For this version, the basic mechanical construction of the original Mode-J Helix has been retained. Pictures received from various builders of the Helix showed excellent construction practices while maintaining the basic electrical criteria. Several builders extended the boom to the rear of the reflector and added a counter weight to balance the antenna (an excellent idea). The reflector can also be round instead of square.

For the Phase IIIB Helix, the electrical design is calculated for optimum gain-per-turn. Again, the basic Helix is six turns with calculations supplied for 7, 8, 9 and 10 turn designs so that the user may build the Helix to match their available transmit output power.

The prelaunch recommended effective radiated power (ERP) necessary for Phase IIIB operation is between 500 to 1000 watts.[1] This value may change somewhat following launch, as we find out how the transponder behaves. Successful operation through the Phase IIIB spacecraft transponder will require right-hand circular polarization both on the uplink and downlink. The use of linear polarization will probably give less than optimum results since the satellite will be spinning on its axis at 30 revolutions per minute, and the 120° spacing of the beam antenna will result in 90 cycles per minute of "spin modulation" when using a linear antenna. A true circular radiation pattern from the satellite will only be received at your QTH when the spacecraft is overhead and its signals will take on an elliptical pattern as it moves away. However, the use of circular antennas at the "earth" station will tend to smooth out the effects of "spin modulation."

It might be well to clarify at this point how to determine the right-hand direction. If you stand behind the antenna and view down the axis, the turns will appear to be wound clockwise as they recede from your vantage.



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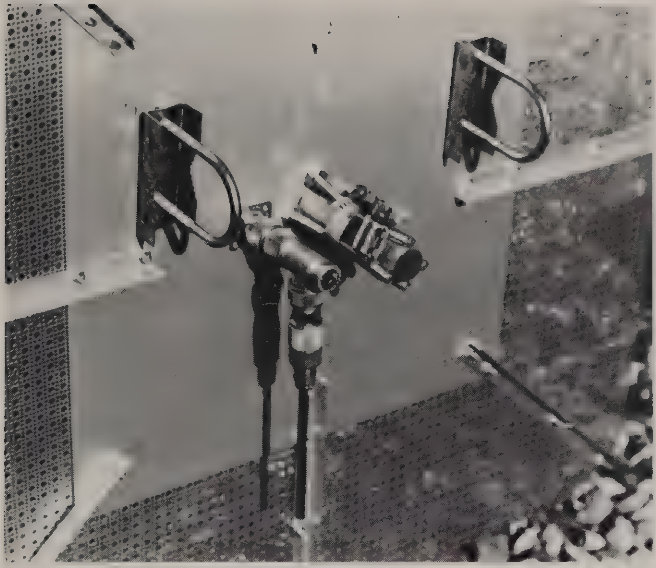
[1] *Mode B estimate is for 500 to 1000 watts ERP. For Mode L, the estimate is 1000 to 2000 watts ERP.*



The Phase III electrical design is based on the following calculations:

$$F = 435\text{ MHz therefore } 1\lambda = 27.1448\text{ inches}$$

$$\text{Right-hand circular polarization, 6 turns}$$

$$C\lambda = 1.16,\ S\lambda = 0.258,\ R(\text{reflector size}) = 0.8\lambda$$

$$\text{Thus } D = \frac{1.16}{\pi} = 0.369\lambda = 10\text{ inches}$$

$$S = 0.258\lambda = 7\text{ inches and the distance between the turns (s) is hence } \frac{S}{2} = 3.5\text{ inches}$$

$$A_xL = NS\lambda = (6)\,0.258 = 1.548\lambda = 42\text{ inches (for } N = 6)$$

$$\text{Pitch angle } \alpha = \tan^{-1}\left(\frac{S}{\pi D}\right) = \frac{7}{31.4} = 0.2228 = 12.56^\circ$$

$$BW^\circ = \frac{52}{C\lambda\sqrt{NS\lambda}} = \frac{52}{1.16 \quad \sqrt{(6)}\,0.258} = 36.02^\circ$$

$$\text{Directivity} = 15(C\lambda)^2NS\lambda = 15(1.3456)(6)(.258) = 31.24$$

$$G_{\alpha i} = 10\log_{10} D = 10\log_{10} 31.24 = 14.94$$

$$G_{dB\,oc} = 14.94 - 1.76 = 13.2\text{ (gain over a one turn loop)}$$

$$\text{Power gain} = +20.89$$

The data for different numbers of turns are shown in Table 1.

From the calculations, one can see that the range of antenna input power is flexible and the ERP can be finalized by the number of turns. For example: A six turn Helix with 48 watts input will give 1002 watts ERP and a 10 turn Helix with 29 watts input will give 1005 watts ERP. In the real world all calculated gain figures will be down about one dB on a carefully built Helix; however, for all practical purposes, these figures given will hold true for building a high performance Helix.

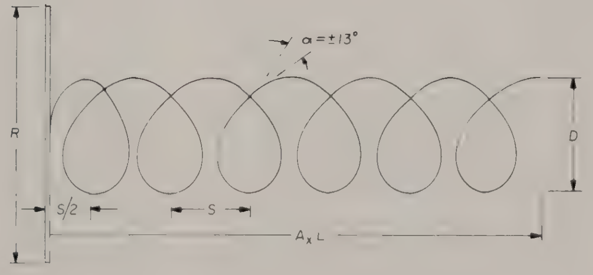
Table 1

N (turns)	*BW°*	*G_C*	*PG*
7	33.35	13.85	+24.26
8	31.20	14.43	+27.73
9	29.40	14.94	+31.18
10	27.90	15.40	+34.67

For optimum results, the purist will want to use type "N" coax connectors in the feed system. Above 150 MHz the use of standard uhf connectors will cause impedance "bumps." However, in the feed system as used, the author has found no practical difference between them.

Acknowledgements

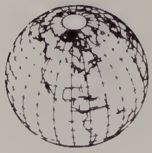
The author wishes to acknowledge K0SMI, W0CA, W0VO, W6WNK, W7KMF, W9DKT, W4MID and others for their pictures, letters and helpful hints on construction and operating experiences.



The Helix design.

G3IOR

Worldwide Satellite Activity



By Pat Gowen, G3IOR*

A considerable enhancement in Mode 'A' activity has been evidenced since the activation of the Soviet 'RS' series of 'RADIO' satellites.

With the probable exception of UF6, UJ8, UH8 and UA1 Franz-Josef, all the USSR countries are now active on the two-to-ten mode, which, coupled with the higher orbits, and the continuous activity of 'RS-6' and 'RS-8' with 'RS-5' often thrown in for good measure, has brought many areas into mutual communications distance.

George, VE2LI, has been adding to his satellite cw score by working UA1CNA, LZ1AB, UO5OGX, UT5BN, UP2BJD, UR2-JL, HG1ZA, and UP2CG in Europe, then way out into Asia with UA9FDZ and UA9FAD. EA8CS supplied Africa, and to top the lot George worked KH6IBA to join the illustrious ranks of those with the distinction of WAC-Satellite.

Somehow finding a few moments between their heavy AMSAT responsibilities, VE2VQ, W3IWI, K1HTV/3, W2RS and WA2LQQ all managed that long and difficult path out to KH6IBA and WH6AMX to get Oceania and WAS-Satellite, plus W2YY, W3CWG, WA2CBB, W2BXA, WA1ZUB, W1NU, and K4UAS.

Rich, aided by his unusual working time schedule, has been making the most of the odd times that he can operate, and has been a consistent and reliable signal into Europe on many orbits, giving 'first W' to many stations in East Europe. The K1HTV/3 log has an ever improving listing of DX worked, starting with UA1CNA, then UW4NI, and hot on the press at the time of writing, UA9FDZ!

Gordie, VE5XU, has been very active, working lots of the newly available European DX, and was a prize for Alex, UA1CNA, a further example of the sort of ultra-dx possible if one really tries. VE5XU is now hunting hard for EA8CS for his WAC-Satellite, while Rich is gunning for LZ1AB, both of which will probably have been accomplished by the time you read this, with new targets in line.

Even your author made QSO's with UI8ADT, and thanks to Andy, WA5ZIB, a good solid QSO with Texas at long last, thanks to late night and early morning insomnia at both ends of the path!

Both Bob, G6RH, and I are very surprised at the lack of both South American and African stations on the new satellites, as well as nothing heard from the West Indies. We are assuming that the word has yet to get out to some of these rarer areas, and that the ever Westerly path for the same time period will result in mutual activity probability once the possibilities are known more generally.

Bob sends an impressive listing of active stations, and has so far logged the following: W1NU, W2RS, W1JSM, W2GFF, K3VIH, K4GSX, N4AR, K1HTV/3, W3LDY, W4CKD, W4MOP, WA1ZUB, KA1GD, K2ZRO, W8DX, W9KDR/1, VE1BB, VE2LI, VE5XU, UA1CNA, UK1AAA, UP2BCE, UP2BJB, UP2CG, UR2JL, UA3VDH, UA3VVH, UK3ACM, UK3MAV, UV3EH, UW3HV, RA3AGS, RS3A, UA4AQ, UW4NI, UB5CUO, UB5MGW, UB5LBT, UB5VAJ, UK5MAA, UT5BN, UD6DFD, UL7DD, UL7GBD, UL7QO, UI8IAN, UA9CKW, UA9FAD, UA9FDZ, UK9SAD, UA9SEN, OX3WS, with lots of DL, G, OE, OK, YO, YU, EI, LZ, ON's etc. Bob is now at 97 countries worked, with 93 confirmed, and with 2523 different stations worked by satellite in five continents. With all W and VE call areas, and 41 states worked, one may safely assume that Bob rarely misses an orbit—if you don't hear him, you can bet he is there listening for a new one!

Grave problems exist to satellite operating on the two-to-ten mode at this time, due to many factors. Man made noise, non-suppressed electrical equipment, cars, enormous line time base harmonics from TV Rx's, strong harmonics from BC stations, woodpeckers, terrestrial fm and even ssb stations in the passband, enormous ionispheric attenuation on daylight paths, auroral activity, and last but certainly not least, the use of powers some hundred times greater than that which is necessary, all make Mode 'A' DX-chasing a very challenging occupation. Much of the time over Europe, the satellites, despite their 10 dB attenuators in circuit, are really cut up, as they do not appear to have the dynamic range of the later OSCARs. Their high sensitivity, while having such advantages for marginal signals, is rendered useless by the brute force and ignorance of those who persist in running powers vastly above the advised level. Experiments on the satellites are made virtually impossible by Wednesday users, many of who quite well know the requirements, but persist in their activity despite advice and requests to abate. If each of us write and tell the worst and most regular offenders of the problems they are causing, rather than trying to bring our own power levels up to theirs in order to be heard, we will all have the benefit of hearing and being able to work those stations who can only be heard when the satellite is sub-horizon to abusers. My own belief is that the Africans and others needed are there, but are attenuated and blocked out for most of the time that we can get access. Only by advice and persistent education shall we ever be able to make the satellites tenable and workable by all to the mutual advantage of every user instead of the few. I receive many complaints of 'hogging' of the ROBOTs, QRO abuse, cw in the ssb end, but mainly vice-versa, persistent QRM of high power stations sitting on top of weaker ones, Wednesday operation, etc., etc. and in each case I have informed the problem user, to no avail. If we ALL tell them, it is worth the time, trouble and cost if it works in the end, and sanity of operation comes into vogue.

At least one of the natural problems can be advantageous, that of the very high MUF, causing the severe attenuation.

Despite the weak downlink, often the problem users tend to ignore the difficult daylight passes, and signals from the satellite can be heard a long way below the horizon, frequently, in fact, much stronger than when the satellite is above 0° elevation. Many of us are hearing signals long before we have access, and are able to pre-calculate the correct uplink, and keep trying to get the first sign of early access, which can often result in an optimum QSO distance, as when refraction is so high at 29 MHz a distinct sub-horizon 2 meter access is possible. It was by this means that WA5ZIB was worked, and nearly W5VVR. Signals may be heard while the satellite is over Oceania over daylight access paths, while the strong RS-3 and RS-4 beacons frequently give excellent antipodeal reception. It is interesting, providing no QRM is given, to try to call the station being heard over the satellite direct on the 29 MHz downlink frequency, and noting that often the ionispheric path is not open to the other station, but the satellite path is.

Recently a number of OSCAR 8 and RS-8 or RS-6 passes have occurred in tandem, with both the satellites at the same point and at the same elevation, when the 'RS' downlink has been multi-path, spread, and with a very rough auroral tone, yet the OSCAR 8 downlink has been virtually a pure T.9 note. Ben, W2BXA, on RS-8 got a RST 44A from me, while W1IAS, simultaneous, but on AO-8, got RST 589. The satellites were both coming through the same atmosphere, F1, F2, and anything else up to the OSCAR 8 height to get their signals to me at the same angle, yet a marked tonal degredation was present upon RS-8 up at 1030 miles, thus giving evidence of an effective layer much higher than the F2 maxima, a zone that we as amateurs may well explore with our satellites.

*17 Heath Crescent, Hellesdon, Norwich, Norfolk, NR6 6ND

W6 SPACE PHILOSOPHER

By John Browning,* W6SP

Enjoying a "busman's holiday" is an expresion which refers to the proverbial, hardworking bus driver who spends his cherished annual vacations touring on a bus. It seems to me that very few individuals find relaxation in an avocation closely related to their vocation. So far the amateur space program has been able to accommodate the few of us who are completely obsessed with space communications and who are therefore happily involved as professionals *and* amateurs. The opportunity to view the rapid development of this useful new technology from parallel perspectives is stimulating and rewarding. As with the general ham population, the majority of amateur space enthusiasts emanate from various walks of life. Their diverse outlooks and enthusiastic approaches are a major factor in the successes of amateur satellites in orbit.

AMSAT membership reflects the same population split. We are an organization composed of a few busmen and thousands of non-busmen. We enjoy the satisfaction of contributing to an effort which is not only exciting and entertaining, but also worthwhile. Engagement in many leisure activities can be justified on the basis of enjoyment and relaxation alone. Amateur radio is unique, however, in that it requires the utilization of a precious, limited reaource—the electromagnetic spectrum. Pleasure alone is inadequate justification for exchanging signals through space. For that reason AMSAT functions as a non-commercial, scientific corporation. Our objectives emphasize experimentation, skill development, and information dissemination. Participation is open to all. Two-way satellite operation is available to any licensed amateur.

As a means of implementing our objectives, many amateurs have conducted classroom demonstrations of live, two-way communications through OSCAR satellites. The enthusiastic response of young science students witnessing vhf and uhf DX communications is a clear indication of the educational benefits of the demonstration. They see first-hand the effects of doppler shift and the azimuth and elevation movement of antennas. Even a casual observer would agree that, from the standpoint of imparting technical information to the students, the technique is very successful. Future career goals can be established. A public service is performed. But what about the non-busman who conducts the tour into space? In equipping himself with the ability to manage the successful demonstration, a machinist, research physicist, medical doctor, or retiree gains an awareness of the intricacies of space communications and the ability to utilize a new medium in a practical way. From the standpoint of skill development, the self-education of the teacher may be as important as the education of the student! Considering the total result, it is obvious that a useful technical resource is being developed.

Through the dedicated efforts of hundreds of enthusiastic volunteers, the amateur satellite program continues to meet its objectives. Utilization of the high-altitude OSCARs of the future will further disseminate knowledge of space technology, encourage the use of higher frequencies, and facilitate emergency communication.

In the meantime, don't ignore that weak "CQ OSCAR" on mode J. It might be some lonely bus driver!

Comets

Geo-Synch Launch Slots Hopeful

AMSAT Officials in Washington and Marburg recently were discussing options afforded by two major launch opportunities as possible follow-ons to Phase IIIB. Phase IIIB, the first in the series of high-altitude, long-lived Amateur Radio satellites is due for launch this Winter.

The first new launch opportunity being discussed is a U.S. launch in a test vehicle scheduled for late 1983 or early 84. AMSAT's payload would supplant a mass simulator that the U.S. government would otherwise have to contract (and pay) for. AMSAT would manufacture its modules to simulate the mass characteristics of a government payload to be flown later. The AMSAT payload could amount to 500 kg or more (more than 1200 lbs; half a ton!) and include many a device fancied by today's most ardent dreamer. The platform would be spin-stabilized and virtually large enough for a cluster of elaborate antennas. Power and stability come free to the passengers (us).

As a test launch, it is presumed to be slightly more risky than one that has been well-tested such as a Delta launch. Delta has been launched literally hundreds of times. In return for accepting the risk a prospective passenger gets a million dollar opportunity to a geo-synchronous orbit. As discussed recently, a so-called geo-synchronous drifter may offer the near-term solution to the problem of serving a world amateur population from a geo-synchronous satellite which by definition can see only slightly less than one third of the earth's surface at any given instant. The drifter would be placed directly over the equator just as the true synchronous birds are. However, the drifter would be at a slightly different altitude so that its sub-satellite point moved over the equator. If stationed a bit higher than the true geo-synchronous birds, the drifter would appear to travel slowly from east to west. Conversely, if the drifter were lowered a bit it would appear to move from west to east. By adjusting the altitude one could determine in advance the rate of change of coverage zones. One rate suggested by AMSAT President W3IWI was a rate that would have the sub-satellite point (SSP) circumnavigate the earth at the equator once per month. This would provide the user 10 days of continuous coverage followed by 20 days of non-coverage. The non-use time would always be twice that of the use time since the illuminated area can be no more than one third of the earth's surface. In other words, you can determine how long you would like the continuous coverage period to be but the "out-of-sight" period will always be twice as great. That's what a synchronous drifter is all about.

What could we get on this bird if we do get a berth?

Well a half ton is a big, big berth to fill and some folks are itching to get some exotic new boxes up there. Big antennas to reduce ground station requirements, packet radio repeaters, broad-band transponders, you name it!

Meanwhile on the European front, Dr. Karl Meinzer, DJ4ZC, AMSAT DL President at Marburg is pursuing an interesting lead on the next generation Ariane from the European Space Agency. The new, bigger, more powerful Ariane is called Ariane 4. ESA has announced a launch opportunity for experimenters (such as AMSAT) in the 1985 time frame. This would be for a geosynchronous launch from the ESA facility at Kourou and allow a payload of up to 2000 kg (4400 lbs) on the upper section of the payload package and 1000 kg (2200 lbs) on the lower portion. Using the upper section AMSAT could place in geosynchronous orbit one each Porsche and BMW! If motor cars in orbit seem less than maximally useful, imagine what manner of amateur radio/scientific payload might be substituted for these famous German automobiles! The prospects of this Ariane 4 launch will certainly bring many in the amateur space consortium into the arena. France's burgeoning Arsenne group will certainly play a leading role in filling the payload bay on Ariane 4.

**Chairman, AMSAT Board of Directors.*

Low-Cost Computer Project

By Bob Nickels, KE0T

A look at a very special version of the popular ZX-81 tailored by AMSAT for tracking tasks.

How often have you wished for a third hand while tracking OSCAR or RS? When was the last time you missed a pass due to faulty orbital data or a defective calculation? Clearly such tasks are within the capabilities of "off-the-shelf" microcomputers and our Command Stations plus a few others have been relying on them to compute and track satellite positions for several years already.

Substantial barriers to general use of computers for amateur satellite activities exist. In spite of advances in the state of the art and economy of scale afforded by mass production, the cost of a computer system capable of performing the needed functions remains high. For satellite tracking and calculating orbital distance, range, bearing, and Doppler shift, the cost can easily exceed that of a deluxe hf transceiver. Adding the necessary hardware to automatically "point" the station antenna can add the price of a shiny new kW amplifier to the total. The effect of the high entry-cost is to limit computer-controlled stations to a handful of operators.

A ZX-81 goes under the knife.

A recently-formed "task force" has decided to attack this problem head-on. Our team has undertaken to design and build a Satellite-Expansion Interface for the very popular Sinclair ZX-81 Computer.

Over 250,000 of the 8 ounce ZX-81 microcomputers have been sold world-wide making it the most popular computer ever. The tiny 15 cm square (6 inch square) machine includes a Z-80 microprocessor, 1,024 bytes of programmable memory, touch-sensitive keyboard, video display rf modulator for standard TV set and a powerful BASIC dialect that includes floating point math and scientific functions needed for orbital computation. The ZX-81 was chosen as the best low cost computer with the power to do the job. The Sinclair unit sells for $99.95 assembled and tested. The unit is not available in kit form.

The following "enhancements" are planned for the ZX-81 AMSAT expansion:

1) *16K of programmable memory.* This is needed to load the sophisticated BASIC programs needed for orbital calculations.
2) *A real-time clock/calendar.* This hardware function provides accurate "time of day" information to the satellite tracking programs by allowing the computer to "know" the correct time.
3) *Interfaces to antenna rotor controls* (azimuth and elevation) for automatic antenna positioning. This task is an example of a job done poorly by humans but very well by a machine. A low-cost solution is needed, however, rather than costly A/D and D/A converters used in existing schemes.
4) *Parallel Input/Output Expansion.* Addition of one or more 8 bit ports enhances the usefulness of the ZX-81 in other applications such as Morse decoding, station control, etc.

5) *Serial Input/Output Expansion.* With the ability to communicate over a serial data channel the ZX-81 decodes UoSAT Telemetry, generates and receive RTTY, and converses with a variety of peripherals such as printers, modems, etc.

A preliminary design review demonstrates that an expansion interface incorporating all of the above features can be assembled to reach the user at a price comparable to the basic computer. Pricing depends largely upon the configuration of the final design and could vary a bit. Availability is tentatively planned to include full and semi-kits and bare boards. Fully assembled systems may be offered.

The project, tentatively dubbed "AMS-81 Expansion Interface" is past the drawing-board stage; a prototype memory expansion has been completed by WA5ZIB, a member of the technical team. Several satellite tracking software conversions have been made already including the W3IWI program as adapted by ZS1BI. The project leaders plan to have a working prototype soon. Anyone interested in helping with hardware or software development tasks is urged to contact either KE0T or KO5I. Completion of this project will bring a powerful and affordable new resource to the AMSAT membership.

Comets

1982 Dayton Hamvention

The AMSAT Booth staffed by WA2LCC, W3HV, and N3CHZ.

W3GEY, KE3D, W3IWI pause for a conference.

The AMSAT Booth at Dayton

W4AUZ shows listing to W6XN.

An Introduction to Orbit Calculations

By Winston Cope*

How the geometry of orbits is handled in a computer program.

The microcomputer provides the amateur satellite user with a powerful tool for calculating orbits. Recently, Tom Clark published such a program for a North Star computer.[1] This BASIC program yields many useful numbers such as ground path, doppler shift, etc. for a choice among several satellites in circular or elliptical orbits. His program corrects for the nonspherical shape of the earth and yields quite accurate results. William McCaa translated this program into Applesoft, the version of BASIC used with the popular Apple-II computer. This program is available through the AMSAT Software Exchange. (See page 4 of this issue.)

The advantage of the Clark-McCaa program is its accuracy and plethora of useful output. Its small disadvantage is that it is too complex and compact for teaching fundamental concepts to novice celestial dynamicists.

The program EARTHORBIT 1.0 is for the Apple-II, but its style is so simple that it can be easily adapted to any BASIC dialect. Most variable names are identical to those in the Clark-McCaa program. The overall approach is the same, so when EARTHORBIT 1.0 is mastered, one has a good handle on the more sophisticated program.

Inaccuracies in the results are due to the fact that no corrections are made for a nonspherical earth, precession, etc. Also, this program uses a very long, but hopefully easily understandable, method for calculating rotation matrices. These many extra calculations introduce cumulative error because of the limited precision of the computer language.

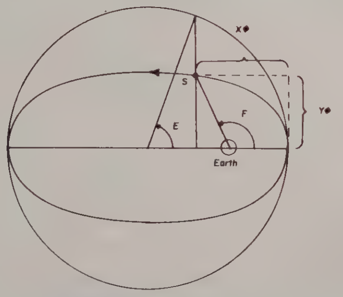


Fig. 1 — The eliptical orbit is contained in a plane.

Using The Program

Predictions of a satellite's orbit points are made based on reference data in the program. Before using the program, the proper data must be written in by the user. The appropriate line numbers are as follows:

40060: G2 is siderial time on Jan 0.0 of the desired year. This number is obtained from the ASTRONOMICAL ALMANAC.

40085: N$ is the satellite name.

40090 - 40170: This is reference information from the weekly NASA bulletins for the satellite desired.

After this information is substituted into the program, it may be saved or run. As the program begins to run, it asks at what time should calculated tracking begin and end, and also the time between orbit points. The output is to the CRT and consists of a simple list of the number of orbits completed since launch, and the latitude and longitude of the satellite's position at each point. Output is kept simple in order not to clutter the program text.

Fundamental Concepts

Gravity is an attractive force which varies as the inverse square of the distance between two free bodies, here the earth and a satellite. This fact, expressed in a space of three dimensions, yields six differential equations. For a good approximation, the earth is a uniform solid sphere. Its gravitational field is then the same as if all its mass were concentrated at its center.

Under these conditions, the differential equations can be solved symbolically, yielding an expression which is a conic section. Thus the orbit is a parabola, hyperbola, or ellipse, depending upon the relative velocity. Satellite orbits are periodic, so they are elliptical. To determine a particular orbit, six integration constants are required. These "orbital elements" may be supplied in several ways, but the most popular form is that used by the NASA bulletins:

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[1] *Clark,* ORBIT *No. 6, March/April 1981.*

**3625 9th Ave. North, St. Petersburg, FL 33713*

1) T0 is the reference epoch time.

2) I0 is the angle of the orbit plane relative to the equator.

3) E0 is the geometric eccentricity for the orbit elipse.

4) O0 is the longitude of the intersection of the orbit with the equator plane as the satellite passes from South to North. This point is called the "ascending node." Its longitude is called the "right ascension of the ascending node," or the RAAN.

5) W0 is the angle taken in the orbital plane between the ascending node and perigee. This is called the "argument of the perigee."

6) the triple (K0, N0, M0) together give information about the size of the orbit and where the satellite is along the orbit at the reference epoch.

Given these data, one can then calculate the satellite's position in its orbit at any other time. The chore of practical prediction of a satellite position at a certain time has two parts. First the satellite must be located along its path. Secondly, this point in space must be expressed in a coordinate system convenient for earth-based observers.

Figure 1 shows the situation for the first part of the chore. The elliptical orbit is contained in a plane. A circle is circumscribed for calculation convenience. Various "angular positions" are defined to be zero at perigee. As the satellite progresses in its orbit, its angular position increases until 360 degrees is reached, back at perigee again. Several kinds of angular positions can be defined for an orbit point, e.g. angles E and F in the figure.

The most easily determined angular position is the "mean angle," or "mean anomaly." This quantity, M, varies in direct proportion to time. It is the position the satellite would have if the orbit were the circumscribed circle of Figure 1.

Once the mean anomaly is calculated, the "eccentric anomaly," E, is derived from it, using Kepler's equation: M = E − (E0 + SIN (E)). This equation follows from the geometry of the ellipse, but there is no solution for E in closed form. Many numerical methods exist, however.

The actual angular position of the satellite relative to the earth is the angle F. This value is derived from M. F is usually expressed in terms of rectangular coordinates as X0 and Y0. This is the situation desired for the first part of the program's chore: the position of the satellite in its orbit. The rectangular system has its origin at the earth's center, with the XY plane containing the orbit, and X points toward perigee.

The second part of the chore involves coordinate transformations. Figure 2 shows how the orbit relates to the "siderial" or "celestial" coordinate system, which is fixed with respect to the stars.

A sequence of coordinate system transformations is performed, each one being a rotation or axes. Three rotations are done, and the order of their execution is important. First of all the orbital plane system is rotated around its Z axis by the angle − W, so the perigee point is mapped onto the equator. Next, this coordinate system is rotated around its X axis by the angle − I0 so the resultant XY plane coincides with the equator. Finally, this system is rotated around its Z axis by the angle − O, so the final X axis is directed toward the vernal equinox. This is the celestial coordinate system desired.

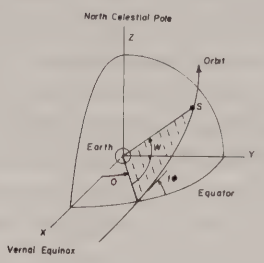

Fig. 2 — The orbit relates to the celestial coordinate system which is fixed with respect to the stars.

The rotation sequence is − W, − I0, − O, with the rotation matrices denoted here as [− W], [− I0], and [− O]. This sequence could be performed step by step on orbit points, but the program first combines the matrices into one composite one, just for fun. The result is:

MW = [− W] * [− I0] * [− O], where * here means matrix multiplication.

The actual transformation from local orbit coordinates to celestial coordinates is then done by considering an orbital point position as a row vector, [X0,Y0,0]. The celestial coordinates are then:

[X, Y, Z] = [X0, Y0, 0] * MW.

Once X, Y, Z are calculated, it is necessary to remember that there is a difference in time scales between celestial systems and earth-based systems. One year in a celestial system corresponds to the number of 24 hour earth rotations for one revolution around the sun. One year on earth is the same actual time, but consists of the number of times the sun appears to go around the sky during one revolution around the sun. There is then one extra "day" here, because the sun makes one trip around the sky per year simply because the earth makes one revolution around the sun per year. The ratio of a siderial time unit to an earth-based, or "solar"time unit is G1 in the program, so the time unit conversion can be made. Solar time at Greenwich is essentially Universal Time, so one can express the orbit point in terms of earth latitude and longitude.

The Program Itself

The main body of the program is very simple.* First introduction is printed. Next, the relevant data are defined, including physical constants and the satellite reference data. Moving right along, relevant numbers are calculated for use later, and then the rotation matrix is constructed.

**See page 29 and 32 for program details.*

Once this groundwork is laid, a loop is entered, one pass per time point. For each point the satellite position in its orbit is calculated via the sequence of mean, eccentric, and true anomalies. The rotation to celestial coordinates is next, and these numbers are then corrected to Universal Time and earth latitude and longitude. With the exit from this loop, the program ends.

The subroutines should be easy to follow. The formulas used in calculating the various "anomalies" are standard and are in any textbook of celestial mechanics.[2]

The matrix subroutines are treated somewhat as "procedures." "Parameters" are passed to them as input, and they return output in only one place. This is somewhat bulky in BASIC, but lets the subroutines be very portable. Indeed, these particular routines were lifted directly from a graphics program.

Testing the Program

Data for OSCAR-8, also known as 7826 B, was written into the program from the NASA bulletin for January 4, 1982. This bulletin also gives the times and longitudes of south-to-north equator crossings for the satellite, i.e. the longitudes of the ascending node. By bracketing these times with the program's calculations, and choosing a fairly small time interval, one can compare crossing longitude values calculated by the program with those predicted by NASA.

For 1/3/82, with calculations beginning at 0700 UT, for 10 minutes, with 0.5 minute intervals, EARTHORBIT 1.0 yields an ascending node at 174 degrees.

For 1/4/82, beginning at 0015 for 10 minutes at 0.5 minute intervals, the program predicts an ascending node at between 72 and 73 degrees. NASA says 71.91. By 1/8, the difference in longitude predictions is 3 degrees.

The closer the times for calculation are to the reference epoch, the more accurate are the results. This is because there is less time for cumulative errors such as the nonspherical earth, atmospheric drag, etc, to perturb the satellite from its ideal path.

Comets

I have at hand *AMSAT Satellite Report* #23/24 dated 31 Dec. '81. Though the specified deadline has passed, I request a "20th" Certificate based on the following:

Soon after the appearance of Sputnik (1) I quit my job with the California Division of Lockheed to accept employment with the Lockheed Missiles and Space Division as Lead Tech at Vandenberg AF Base near Santa Maria, Calif. We were to install all of the Communications equipment for the USAF Discoverer Project. Some time in 1958-59 I read an article in a Ham magazine describing a small, light-weight transmitter designed by Don Stoner for use in a high-altitude balloon flight for propagation study. Don ended his article with a whimsical query, "Anyone got a rocket?". I started thinking: "After all hams *had* pioneered practically all of early radio development, and, by golly, they should also have a part in developing Space Communications. I wrote Don, asking if he would be willing to help me get an Amateur Radio Space effort going. His enthusiastic answer was all I needed. I wrote to the Lockheed VP and General Manager in charge at Sunnyvale and asked if there was any possibility of hitchhiking a small amateur beacon on one of the Discoverer birds. He didn't even acknowledge my letter, BUT it was read by a ham on his staff who later came down and suggested we get some heavy-weight hams on our side, and try again... The first I chose was Ray Myers, W6MLZ, who I think at that time was an ARRL Director, asking in turn for him to enlist other well-known amateurs to the cause. It took quite a few years, but we never gave up. By far the hardest job was to secure official approval. Here I enlisted the aid of Al Barnabei of the US Dept of State, who appointed an aide, Dick Black, to act as liaison. On our end we luckily had Bill Orr as the only one who could afford to make the trip, and they went to a meeting of the IARU, and did get the okay. Next, of course, was the hitch-hike approval. Here the USAF was really hard-nosed. At the suggestion of Bill Orr our Director of Public Relations, I "leaked" the story of OSCAR'S plight to *Aviation News*, well-aware that I probably would be the sacrificial goat. Very soon after I resigned as President/Chairman of the Board we did get an OK from USAF. The rest is history, but no one else can claim that I was not in fact the originator of Project OSCAR.

Back then, I still had my original (1931) call sign, W6EJU, and lived in San Jose, Ca., where I tracked OSCAR 1 with both my own equipment and that of the LERC Amateur Radio Club. I was at the Club station when OSCAR 1 made his last pass, and even though its HI rate was extremely fast, it was still loud and clear. My good friend Nick Marshall (who I note is still active with OSCAR North) determined the temperature was very close to the burning temperature of the magnesium case. Not many people know that the stainless steel antenna was followed by USAF for two more orbits after the radio failed.

At present I am only copying tlm from OSCAR 8, but as soon as my financial position improves I will build (or buy) a 2-meter cw rig and will see what I can do via the available ham satellites. *—Fred Hicks, W7DBU*

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[2] Brower, Methods of Cellestial Mechanics, *Academic Press, N.Y., 1961*

Phase IIIB Special Service Channel Utilization

By Richard Zwirko,* K1HTV and Bob Ruedisueli,** W4OWA

Part II of an intriguing discussion of Phase III planning: Special Service Channels.

The proposed Special Service Channel (SSC) utilization was discussed in detail in *Orbit* #10. It was pointed out that the multitude of activities proposed for the Phase IIIB SSCs would require the establishment of a world-wide coordination plan. This plan was found desirable to insure flexible and optimum use of the SSCs thus best serving the interests of the community of radio amateurs.

This article proposes a plan for SSC coordination and a suitable organization to administer the plan. The basic motivation for this proposal was stated in the previous article. It is worth repeating here: "Disciplined use of the SSCs will be imperative, SSC use must, of necessity, be non-competitive. Therefore, coordination and mutual cooperation is a prerequisite. Both planning and organization is essential."

This proposed coordination plan and organization is intended to support the six types of services proposed for the SSCs, namely:

Transmission of General Bulletins
Presentation of Educational Programs
Implementation of Scientific Programs
Implementation of AMICON Programs
Support certain special cw/RTTY Traffic
Support certain special Activity Networks

In addition, this proposal recognizes the need for the three distinct efforts required to carry out each service. That is:

Program Planning
Coordination and Scheduling
Program Implementation

All three are required to guarantee maximum equitable use of the SSCs.

Finally, the proposed coordination plan endeavors to recognize the global needs of the Amateur Radio community and the service that its satellites could offer those interested in space communications technology.

Program Planning

Behind every program planned for the SSCs there will be needs and ideas. These may originate anywhere within, and in some cases outside of the Radio Amateur community. The proposed plan would provide a means of assimilating these needs and ideas and converting them to worthwhile programs.

In order to accomplish this it is proposed that individuals in each of the three IARU (International Amateur Radio Union) regions be appointed to manage the planning of SSC programs in each of the following areas:

Education
Science
AMICON activities

Addtional individuals within the Regions would be appointed to manage the planning aspects associated with:

General Bulletins
cw/RTTY Traffic (where permitted)
Special Network Activities
Emergency Communications

These program managers would be responsible for gathering ideas and responding to needs arising in their "jurisdiction." These ideas and needs would be gathered through appropriate input from the originators. (See Fig. 1.) This would be accomplished

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*Vice-President, Operations
**AMSAT Hq. P. O. Box 27, Washington, DC 20044

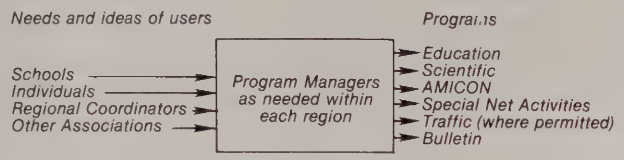


Fig. 1 — Needs generate programs.

via personal contact, letters from individuals, clubs or organizations, contacts during net sessions, etc. The managers would then be responsible for the planning of one or more programs designed to satisfy specific needs utilizing the best of all available ideas. The Education Program Manager would tend to the needs of educators, students or anyone interested in *learning* about space communications. This manager would plan programs utilizing the capabilities of SSCs H1 and H2. The contents of transmissions made by those involved in the Education Program might cover topics such as orbital parameters and their meaning, how to improve uplink and downlink signals, spin modulation and other such topics. The SSC also could be used to link students in classrooms in different parts of the world, involving them directly with space communications.

The Scientific Program Manager would proceed in a similar manner planning programs utilizing primarily the H1, H2 or the L2 SSC depending on the content of the experiment. One experiment might find individuals tracking the low orbiting UoSAT satellite relaying telemetry data in real-time via an SSC. Another experiment (already in the talking stage) is one which would relay data from a GAS (Get Away Special) aboard a future Space Shuttle mission through a Phase IIIB SSC.

Bulletins intended for transmission on the SSCs (ssb normally on H2, cw/RTTY on L2) would be routed directly to the various Phase IIIB bulletin stations by the International Amateur Radio Union (IARU), or IARU societies, ARRL, or by AMSAT or any other Amateur Radio organizations. These bulletins, intended primarily for Radio Amateurs, would contain items of national or international interest. Topics covered would include hf propagation, reports of solar and geomagnetic activity, DX information, satellite operating status reports, orbital predictions and other items of interest.

Traffic Managers and Special Activities Net Managers would look to the requirements of various cw/RTTY long-haul traffic schedules such as the Trans Continental Corps in the U.S., and on ssb the international AMSAT nets which, for many years, has had to contend with the vagaries of hf propagation. While on the topic of third party traffic, it must be pointed out that although the handling of such traffic is allowed in the U.S., Canada and some other countries, this activity is strictly forbidden by the majority of countries. Phone patch traffic, which seems to have overrun the upper half of the Amateur Radio 20 meter band, would be a detriment to the Phase IIIB passband if it were allowed to grow in a similar manner. AMSAT strongly recommends that, though they might be ok in a few countries, phone patches should NOT be conducted on the Phase IIIB satellite except for extraordinary situations, e.g., where no commercial telephone or radiotelephone circuits exist. A good example might be an Antarctic scientific research site or an Arctic expedition across the tundra or a polar ice flow. Phone patch traffic in such circumstances probably would be viewed positively. However, so-called ''priority phone patch traffic'' between two areas which have regular communications facilities is strongly to be discouraged.

The Emergency Communications capabilities of Phase IIIB will be great. Planning must be done in each region for possible use of one or more SSCs during earthquakes, floods or other natural disaster when normal communications are unavailable.

Although not proposed as an SSC, the AMSAT Net and Calling Frequency, ANCF, could become the primary emergency listening channel if Amateurs monitor this one frequency when not making QSOs via Phase IIIB. This frequency could be used by many individuals who would want to share information such as E skip, aurora, trans-equatorial scatter or other such openings on the vhf bands. The present hf International AMSAT nets are expected to eventually move at least part of the net operations to the ANCF.

AMICON (AMSAT International Computer Network) activities which will take place on the Phase IIIB satellite's L1 Special Service Channel will consist primarily of the exchange of digital packets. Since AMICON's users will be worldwide, a requirement exists for the development of standards and protocols. This will differ from other SSC programs which will be developed by regional program managers based on the needs in his particular region. AMICON program managers in each region, on the other hand, would direct activities associated with AMICON based on the recommendations of the AMICON Planning Committee. The Committee has been working on those tasks. A number of recommendations has resulted. One of these recommendations concerns the required bandwidth of AMICON. In issue number 10 of *Orbit* Magazine a 5 KHz bandwidth was mentioned. After further study of the matter however, the Committee has recommended that the channel bandwidth for transmission of digital data (such as in the AMICON Program) be increased to 15 KHz. This appears required by engineering considerations of the modulation technique recommended for the first phase of AMICON development. Certain stations would act as gateways, linking worldwide users of this digital communications system. More on the subject of AMICON standards and protocol will appear in a future issue of *Orbit*.

Coordination and Scheduling

In planning their programs and activities, Managers within each IARU Region will require SSC "air-time." Contention will result occasionally. Obviously, overall coordination will be needed. This proposal requires the appointment of SSC coordinators for each IARU region. Initially, these coordinators will be the present AMSAT regional coordinators. It will be their responsibility to review all demands for SSC use in their regions and then make appropriate SSC schedule assignments. They would resolve any contentions, establish schedules for SSC usage in their regions and finally pass this schedule information to the program managers in the respective regions. (See Fig. 2.) Any inter-regional contentions which might develop would be settled at the regional coordinator level.

Program Implementation

As part of this proposal each of the three Regional Coordinators would act as an interface between the program planners within his region. Program Managers would be responsible for developing programs to suit the needs of those in their own country or region. They also would be responsible for notifying participants of the SSC schedules established for their particular program. SSC user stations would be following implementation schedules developed and coordinated by their Regional SSC Coordination Manager.

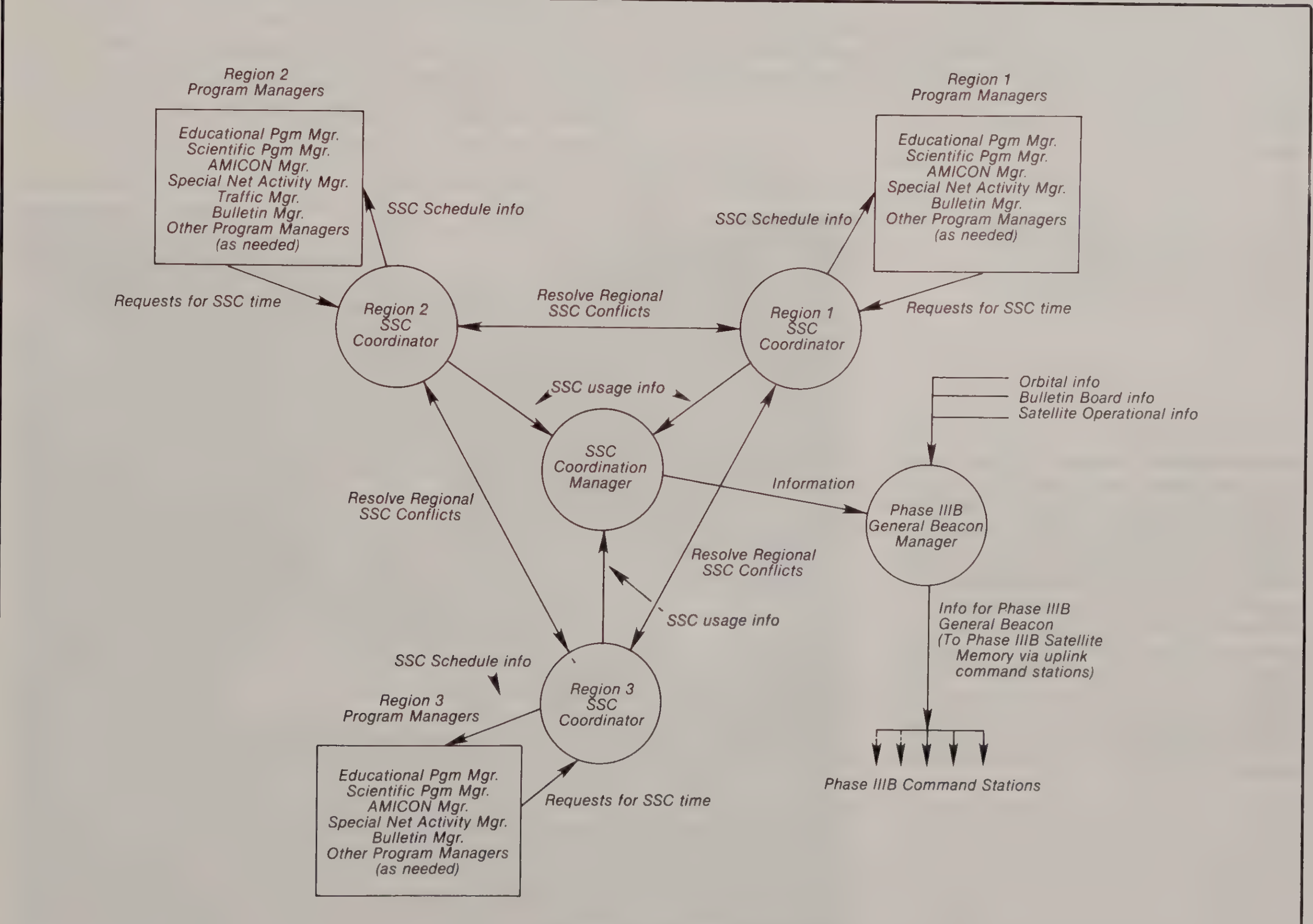
Coordination Plan Proposed "Who's Who"

The AMSAT VP Operations, Rich Zwirko, K1HTV, has assumed responsibility for overseeing Phase IIIB Special Service Channel utilization. To assist with this task it is proposed that an SSC Coordination Manager and a General Beacon Coordination Manager be designated to work with the VP Operations.

SSC Coordination—TBD (to be determined)
General Beacon Coordination—K0CY

In addition it is proposed that the current AMSAT Chief Regional Coordinators would support the VP Operations by becoming the first SSC Regional Coordinators. They are:

Region 1	G3IOR	Europe Africa
Region 2	W0CY	No. America So. America
Region 3	JA1ANG WH6AMX	Asia Pacific



Region 2 Program Managers
Educational Pgm Mgr.
Scientific Pgm Mgr.
AMICON Mgr.
Special Net Activity Mgr.
Traffic Mgr.
Bulletin Mgr.
Other Program Managers (as needed)
SSC Schedule info
Region 1 Program Managers
Educational Pgm Mgr.
Scientific Pgm Mgr.
AMICON Mgr.
Special Net Activity Mgr.
Bulletin Mgr.
Other Program Managers (as needed)
SSC Schedule info
Requests for SSC time
Region 2 SSC Coordinator
Resolve Regional SSC Conflicts
Region 1 SSC Coordinator
Requests for SSC time
SSC usage info
Orbital info
Bulletin Board info
Satellite Operational info
SSC Coordination Manager
Information
Resolve Regional SSC Conflicts
Phase IIIB General Beacon Manager
Resolve Regional SSC Conflicts
SSC usage info
Info for Phase IIIB General Beacon (To Phase IIIB Satellite Memory via uplink command stations)
SSC Schedule info
Region 3 Program Managers
Region 3 SSC Coordinator
Educational Pgm Mgr.
Scientific Pgm Mgr.
AMICON Mgr.
Special Net Activity Mgr.
Bulletin Mgr.
Other Program Managers (as needed)
Requests for SSC time
Phase IIIB Command Stations

Fig. 2 — System coordination scheme.

Please note that for AMSAT planning purposes all Pacific islands will be considered to be in Region 3. Other countries in the rest of the world will follow the IARU region plan.

Under this proposal, the Regional Coordinators would establish schedules for SSC usage in their regions, resolving any contentions which might result and finally would pass this schedule information to the Program Managers in their respective Regions. The following is a list of volunteer program managers for each region. The letters TBD (to be determined) indicate the need for a volunteer for that particular program in that region.

	Reg. 1	Reg. 2	Reg. 3
General Bulletin	HA5WH (IARU)	W1AW(ARRL) W3BWU(AMSAT)	TBD
AMICON Programs	TBD	KA6M	TBD
Education Programs	TBD	WB1EYI	TBD
Scientific Programs	TBD	N1DM	TBD
Special Activities Net	TBD	W8GQW	TBD
Traffic Net	TBD	WB9IHH	TBD
Emergency Communications	TBD	TBD	TBD

Finally, under this proposal, most general bulletin material originating with the following organizations would be coordinated by:

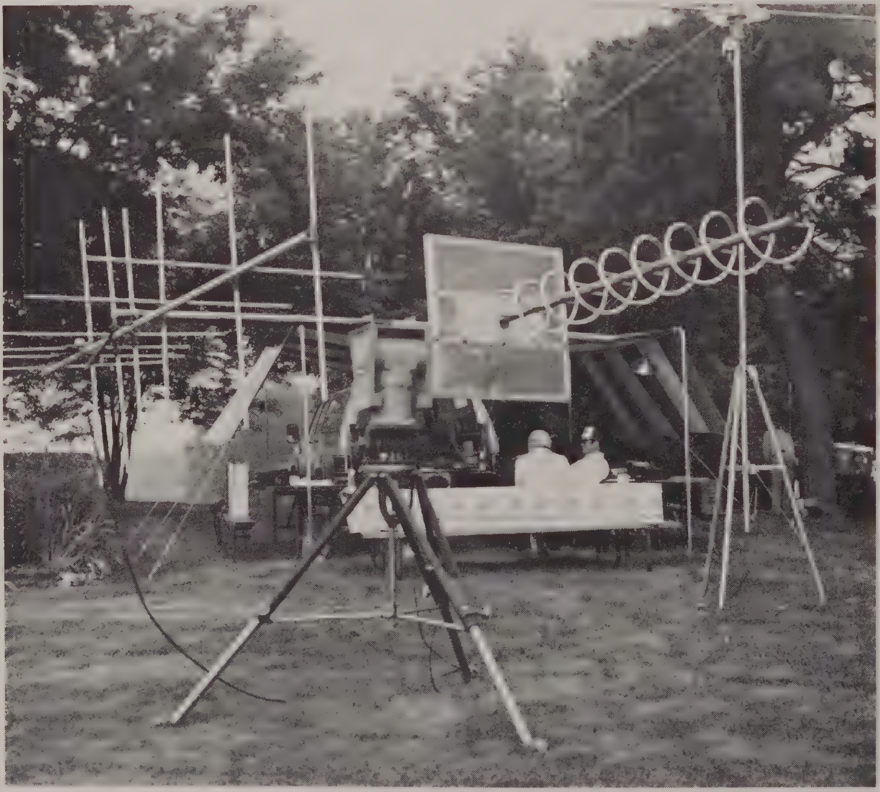
IARU	HA5WH in Reg. 1, TBD in Reg. 2, TBD in Reg. 3
RSGB	G3AAJ (Note that RSGB is awaiting formal approval from its licensing authority for Phase IIIB bulletin transmissions)
ARRL	W9KDR
AMSAT	WA2LQQ
(other)	TBD

Since this is a proposal and still subject to growth and adjustment, the above designated positions and individuals must be regarded as tentative. The task descriptions in this article are intentionally general and are intended to guide the future development of the various programs. AMSAT has tried to avoid over-specifying the tasks at this stage. Rather, we know the *actual* task description and responsibilities will evolve with time and with the decisions that you, as volunteers, will make in your volunteer roles. Although time is growing short there is still an opportunity to make changes. An optimum and equitable use of the Phase IIIB Special Service Channels poses a gigantic task but one that can be managed if carefully and thoughtfully formulated. *Worldwide coordination and mutual cooperation* will go a long way to insuring maximum benefits to all interested in space communications and experimentation!

If you wish to help in any capacity let us hear from you. Please address all comments to the authors, K1HTV and W4OWA at AMSAT, P.O. Box 27, Washington, DC 20044, USA. If you have an interest in developing a particular program within your country or region please contact AMSAT Regional Coordinator serving your area, namely Pat Gowen (G3IOR) in Reg. 1, Jim McKim (W0CY) in Reg. 2, Harry Yoneda (JA1ANG) or Rick Dittmer (WH6AMX) in Reg. 3. These gentlemen can be reached initially via the above address.

We will soon have in our hands, in Phase IIIB, one of the greatest communications tools ever available to Amateur Radio. What good comes of the opportunity depends on what we, the user community, do with it. Let us plan well...and *do* well.

Comets



Some of W0RPK's antennas, shown here during the 1982 ARRL Field Day event, were on display at the recent ARRL National Convention in Iowa. A two-meter crossed Yagi is at the left with a 70cm helix to the right. Both antennas are mounted on a tripod system making it portable. In the rear at the right, there is a 10-meter turnstile mounted on another tripod. These three antennas allow operation on any of the present operating Amateur Satellites. Satellite Field Day operations are a snap with a system like this!

AMSAT News

Organizational items of interest to all members of the Radio Amateur Satellite Corporation

AMSAT Staff Changes Reflect Phase IIIB Completion

With the completion of the Phase IIIB spacecraft at hand, several major changes in AMSAT staffing levels are imminent. First, AMSAT Vice President for Engineering, Jan King, W3GEY, will be reverting to volunteer status. For the past several years Jan has been an employee of AMSAT and has led AMSAT's effort to construct the Phase IIIA and Phase IIIB and C spacecraft. Now, having largely completed that effort, Jan will be going on to a consulting business in the aerospace industry. However, he will remain an invaluable part of the Phase III program and of AMSAT. He will continue living in suburban Maryland and participate fully in AMSAT activities. In fact, Jan observes, I'm certain that over the eleven years I've been doing these things, I've contributed more to the programs as a volunteer than as a paid employee. So thoughts that the end of my direct involvement and strong participation in AMSAT are simply wrong!

Gordon Hardman, KE3D/ZS1FE and Molly Hardman, N3CHZ/ZS1KE, will be leaving the Washington, D.C. area and heading home to South Africa. But not before they have seen a bit of what these United States have to offer. Both are planning a cross country drive ending up in San Francisco. Gordon has been employed by AMSAT in its intern program for a year and a half. Molly has been employed at NASA's Goddard Space Flight Center at Greenbelt Maryland as a programmer/analyst. Gordon will be taking home with him much of the knowledge and techniques learned while at the AMSAT lab in hopes of innoculating the crew at home in ZS with the stuff to begin and bring to fruition the first African amateur radio satellite. Gordon and Molly are both enthusiastic about the likelihood that their native land will produce at least a major portion of a future satellite beginning almost immediately.

AMSAT wishes our friends all the best in their new endeavors!

Radio Netherlands Features Amateur Interest

For some months now Radio Netherlands has been featuring programs of interest to Amateur Radio operators as well as amateur computer hobbyists. Recently, AMSAT'S European Regional Coordinator and AMSAT Director Pat Gowen, G3IOR, of Norwich, England, was interviewed on the air for an international broadcast on Amateur Radio and satellites. Pat recently remarked that he'd "always wondered what it would be like to modulate a megawatt or two!"

In the hobby computer domain, Radio Netherlands is promoting a system called "hobbyscoop." Used in conjunction with broadcasts from Radio Netherlands, this system would "pre-condition" as many as 11 different personal computer types to be compatible with the distribution of software through Radio Netherlands. Mr. Jonathan Marks of the English Section of Radio Netherlands says in a recent correspondence with W6HDO that "A handbook is at present being prepared in both English and Dutch to explain the standard [coding] and a cassette is also being produced to enable easy loading of the translation and example programs into [about] 11 brands of home computers.

A program of potential interest to *ORBIT* readers is broadcast weekly on the hf bands. Mr. Marks hosts the program beginning at 0530 UTC, Fridays. The frequencies on which to listen are: 6165 kHz and 9590 kHz.

Phase IIIB Moves Towards Launch

The Phase IIIB spacecraft was shipped from the AMSAT lab on Friday, 30 July, and has arrived in Germany thus taking a major step towards its historic launch to orbit early next year. The spacecraft recently underwent rigorous thermal-vacuum tests at the Goddard Space Flight Center. During the course of these tests two malfunctions occurred. The malfunctions were revealed in the transponders (one fault each in the Mode B and Mode L transponders) and were consequently returned to Germany with the AMSAT DL crew which attended the thermal-vacuum tests. Back in the Marburg lab where they were built, AMSAT DL engineers quickly diagnosed the failures and had remedies in hand shortly thereafter. The fixes amounted to a minor redesign in the circuits.

Now the entire spacecraft will be re-integrated and prepared for shake and vibration testing but not before the transponders are again subjected to thermal-vacuum testing at the subsystem level. These units will then be potted as were the balance of units which remained at Goddard when the transponders returned to Germany with the DL crew. The shake-vibe tests are now scheduled for the last week in September at a facility in Marburg. At press time the launch schedule was holding with L5 set for 10 Sept. 82, L6 for second half of November and L7 for January 83. However, as has been mentioned in these pages on occasion, any slips in L5 and L6 will likely ripple through the schedule to affect L7.

New Satellite Tracking Telescope On Line

Ever wonder how various government agencies keep track of all the satellites and assorted refuse floating around in orbit? The following news item from the "Washington Report" column of the July 8, 1982 issue of *Electronic Design Magazine* allows a glimpse.

"A computer-driven telescope designed to track satellites as far out as 22,000 miles has been put into operation at the White Sands Missle Range near Socorro, N.M. The scope, which can detect objects as small as a soccer ball in space, was developed by TRW, Inc. (Newbury, Calif.). Called Ground-based Electro-Optical Deep Space Survey (GEODSS), the system is controlled by four Digital Equipment Corp. PDP-11/70's. One hundred images per minute are recorded by a television camera and converted into digital pulses by a custom video processor from Itek Corp. The mainframes then filter out the surrounding stars and display the satellites as streaks of light on CRTs. The telescope is one of five planned around the globe. Korean and Hawaiian sites are to be operational by late summer, and others in the Indian Ocean and eastern Atlantic regions should be up and running by the mid-1980s."

Reproduced with permission. Thanks *Electronic Design*, KB2M.

"Spark" Bird Dies Near Canarys

The newest amateur radio satellite, ISKRA-2, fell from orbit on 9 July just northwest of the Canary Islands. The demise of ISKRA, Russian for spark, had been predicted for late June or early July.

ISKRA-2's birth was unique in the annals of amateur radio satellites, generally referred to as OSCARs. ISKRA-2 was manually expelled from the airlock of the manned Russian space mission Salyut 7 on 17 May. The 28 kg (62 pound) student-built satellite apparently never fulfilled its primary objective of providing a 21 to 29 MHz linear transponder. However, the beacon of ISKRA-2 signing RK-02 had been prominent in the 10 meter band throughout its short life. (See background in *ASR* #33)

ISKRA-2 was in an orbit similar to early OSCARs such as OSCAR 1 which remained in orbit 50 days. ISKRA-2 lasted 53 days. There has been no public comment from the Soviet Union or the Central Radio Club of the USSR as to the nature of the failure which precluded transponder operation. (See *ASR* #38)

(Continued on page 30)

The NASA Satellite Tracking and Communications Network

By Jim Lacy*

About the Author....

Jim Lacy is a twenty year public affairs veteran of the space program; all of it in tracking, data acquisition and communications specialization. A University of Virginia science grad, he has completed graduate studies in telecommunications at the George Washington University Center for Telecommunications Studies, Washington, D.C. Prior to that he was an all-weather carrier based fighter pilot where he received his initial electronic systems training.

When the first electric pulses raced through the wires of Samuel Morse's telegraph, he knew the signals were the beginning of a vast new dimension of communications. Telephone, radio, television and communications satellites were the ultimate result and were successively hailed as modern miracles. Ironically, soon they were relegated to workaday status.

In Morse's day it was a stunning achievement to transmit messages at the rate of 50 words per minute. Today spacecraft communications systems are capable of compressing an eight-minute-long voice message into a transmission lasting less than one-tenth of a second.

Setting foot on the New World in 1492, Christopher Columbus did not know where he was nor how he got there. It took the world years to learn of his courageous trip—decades to readjust. When Neil Armstrong stepped upon the surface of the moon in 1969, he knew exactly where he was and just how he got there. How was this possible? Space-Age communications delivered high speed, compressed information across a quarter-million miles to ground terminal computers in less than one second so that these incredible machines could accomplish their instantaneous computations called "real-time" computing.

In less than five hundred years man's ability to communicate in this astonishingly sophisticated manner has advanced from native African log-drum rhythms to a Skylab mission which saw communications links provide 270 days of continuous spacecraft monitoring while handling 25 million pieces of data per hour.

Mr. Morse may have known his telegraph tapped-out a message that could reshape the world of communications and data exchange, but he hardly imagined to what extent. Nor could Alexander Graham Bell in March of 1876, when through an acid spilling accident, his assistant Thomas A. Watson heard Bell's voice transmitted over wire. "Mr. Watson, come here. I want you!" That command became one of history's most memorable messages.

Certainly Mr. Bell could not have imagined that less than one hundred years later (1957) the world would be astounded by news that instant telecommunications had broken its terrestrial bonds and made the leap into space via the first manmade satellite.

Between 1957 and 1982, some 1500 spacecraft have been launched for a variety of purposes. Most of these were sent into relatively low orbits to study radiation, magnetic fields, micrometeoroids, etc.; some to assist navigation, weather forecasting and as orbiting solar observatories. A few were sent farther into deep space as lunar probes, solar probes, to Mars, Venus and Jupiter.

Historically, one of the most significant of this early group was a sixty pound bundle of technology called Syncom II which was placed into earth synchronous equatorial orbit on July 26, 1963, ultimately revolutionizing world-wide communications.

Syncom II could relay telephone conversations, picture facsimilie and television programs. A successful Syncomm III followed about one year later on August 19, 1964. From its modest beginning, Syncom applications have found their way into the lives and national affairs of over 100 countries or territories equipped with ground stations which give them direct access to an international telecommunications system. A total of 92 countries have joined a consortium called Intelsat; most have their own earth stations. This concept, implemented in 1965, produced a 25-fold growth in inter-

*AMSAT Hq., P.O. Box 27, Washington, DC 20044 national communications traffic in five years.

At the epicenter of this communications revolution was the Goddard Space Flight Center in Greenbelt, Maryland, the nerve center of NASA's worldwide satellite tracking, data acquisition, and voice network (NASCOM).

The genesis of NASCOM can be traced to the Naval Research Laboratory's (NRL) participation in the International Geophysical Year (IGY), 1957-58. The project called VANGUARD was to place into orbit and track the first U.S. artificial earth satellite, and collect data from on-board experiments. Point-to-point teletype circuits routed data from around the world to the Vanguard Control and Computation Center in Washington, DC. The communication network, at this time called "SPACECOM," was expanded to tie in various agencies cooperating in the space adventure via leased commercial circuits. Communications circuits required by the Jet Propulsion Laboratory's (JPL) Deep Space Network (DSN) in Australia and South Africa were being integrated into the SPACECOM on a time-shared basis. This world-wide configuration was controlled by a manual torntape switching system located in the SPACECOM communications center at Goddard.

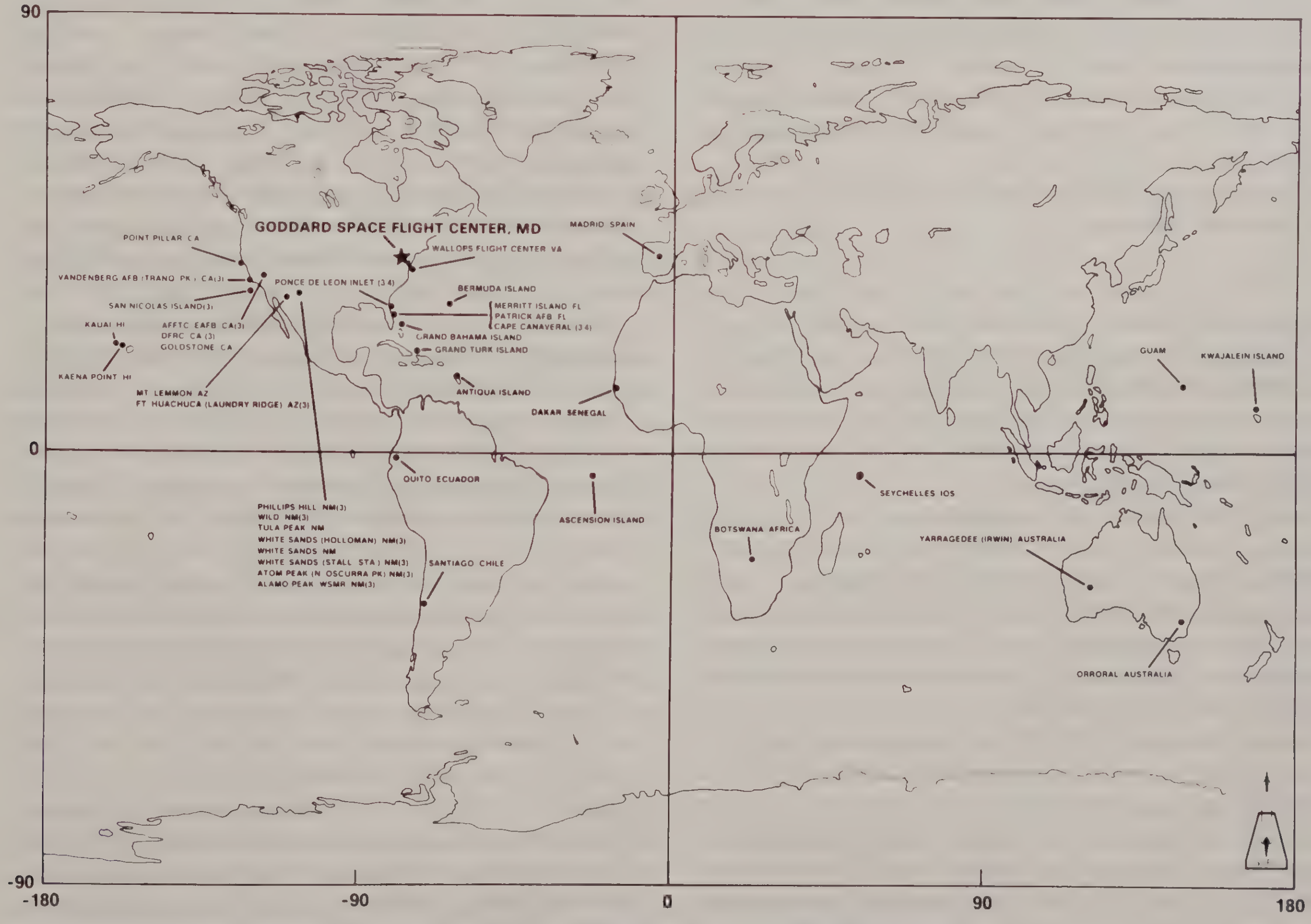
Thus, from that first day in May, 1959, when the Goddard center was established as NASA's first major scientific laboratory devoted entirely to the exploration of space, Goddard has become the Space Agency's most diversified field center.

Housing 3,500 civil service and 3,000 contract support personnel in 28 buildings on 1194 acres, Goddard's history of unmanned orbit payload placement ranges the gamut. The 1.47 pound Vanquard spacecraft was launched on March 17, 1958. Ten years later, the 4,000 pound orbiting Astronomical Observatory went into orbit on Pearl Harbor Day, December 7, 1968. The interim years have been distinguished by the OGO and Nimbus-Tiros series (800-2000 pound range) and the Intelsats (1000 pound range).

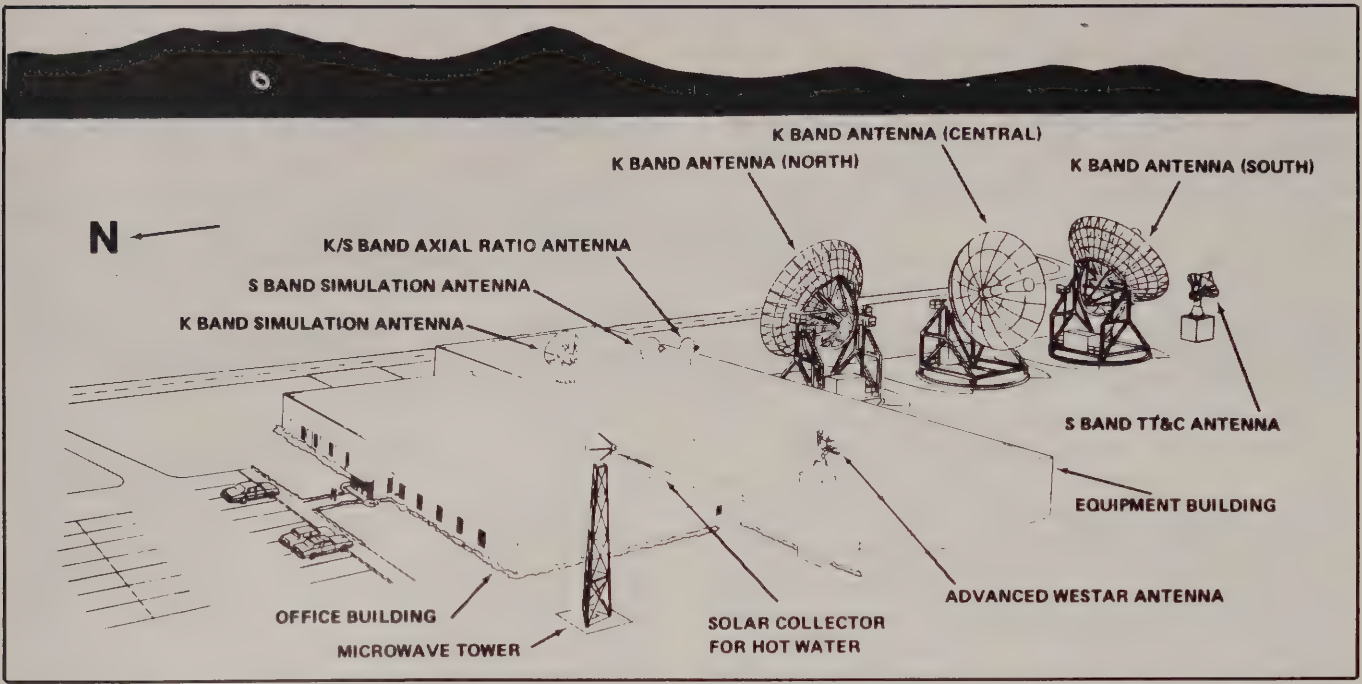
Growth and Development

In 1960, the Project Mercury Network was established, and consisted of a series of radar tracking, telemetry, and command stations. These facilities were linked to the Mercury Control Center at Cape Canaveral, Florida, through a centralized communications technical control center at Goddard. The Mercury network included a mechanically switched TTY network and voice circuit switching system called the Switching, Conferencing and Monitoring Arrangement (SCAMA). SCAMA was installed at Goddard and provided voice communications from the Mercury Control Center to Project Mercury tracking stations for air-to-ground communications.

The growth of the space program led to the develop-



SPACEFLIGHT TRACKING AND DATA NETWORK (STDN)



Artists rendering of the NASA/TDRS earth station at White Sands, New Mexico. It is one of the largest and most complex sites ever built. TDRS systems shared satellites will relay data to and from Space Shuttle, unmanned earth-orbiting spacecraft, and the earth station at data rates ranging from 100 bits-per-second to 300-million bits-per-second. The system offers simultaneous data relay services for up to 32 user spacecraft in orbits up to 3100 miles through 85 to 100 percent of each spacecraft's orbit. All data from the White Sands station will be routed to the various using NASA Centers such as the Goddard Space Flight Center in Greenbelt.

ment of three tracking and two communications networks. Tracking networks were as follows:

a. Space Tracking and Data Acquisition Network (STDN), for unmanned scientific satellites in close orbit (between the earth and the moon).

b. Deep Space Network (DSN), for unmanned scientific satellites performing missions at lunar distances and beyond.

c. Manned Space Flight Network (MSFN), for manned spaceflight missions.

In 1964, the National Aeronautics and Space Administration (NASA) designated its operational long-line communications system the NASA Communications Newwork (NASCOM). It consisted of operational communications circuits and facilities for transmitting mission-related information required for conducting NASA programs and projects.

NASCOM consists of approximately 125 terminal stations, linked by about 2 million circuit miles of voice, low-speed data, high-speed data, and wideband data communications circuits. A real-time Message-Switching System (MSS) uses large and medium-scale computers at Goddard to provide automatic message switching within the network.

NASCOM allows all NASA mission control and computation centers acess to the remote tracking, data acquisition, and command stations. The network supports all NASA projects by providing communications circuitry routed through the primary NASCOM switching center at Goddard, in Greenbelt, Maryland, and remote switching centers at Canberra, Australia; London, England; and Madrid, Spain. Switching center functions are also performed at the Air Force Eastern Test Range (ETR), Cape Canaveral, Florida; NASCOM West Coast Switching Center (WCSC), Pasadena, California; and Western Test Range (WTR), Vandenberg Air Force Base, California. The primary NASCOM switching center at Goddard provides centralized communications operations and control and, in conjunction with remote switching centers, enables primary circuit sharing on costly long-haul circuits.

In most instances, TTY, voice, and high-speed data circuits are routed via the remote and prime switching center at Goddard so that a degree of diversity between the end-to-end remote tracking stations and Goddard is provided. For example, in the case of Madrid a limited number of alternate voice/data circuits are available between Madrid and London in addition to the direct satellite path at the Buitrago Earth Station near Madrid. A submarine cable for alternate voice/data circuits is also used between Goddard and Madrid. Access to these various facilities reduces the probability that a total communications failure will occur under normal circumstances. Alternate voice/data circuits are used to transmit voice, and analog and digital high-speed data. Data rates range from 2.4 to 9.6 kb/sec. In addition, wideband circuits are used in communications with tracking stations at data rates of 56, 224 and 1544 kb/sec. The circuits are routed directly to Goddard or via remote switching centers. Depending on the location of the tracking station, some circuits are routed via the satellite transmission facilities. For tracking stations in the United States, wideband facilities are routed to Goddard NASCOM Technical Control. Overseas tracking station circuits are routed through the remote switching centers then to Goddard NASCOM Technical Control. By routing wideband circuits through technical control facilities at the switching centers, troubleshooting, monitoring, and circuit restoration can be accomplished as required.

Also included in the network are speech-plus-teletypewriters (Voice Frequency Telegraph (VFTG)) and Time Division Multiplex (TDM) circuitry. These systems combine several circuits with distinct functions in one system which results in a considerable savings when applied to long-haul circuitry.

A more recent communications advance in NASCOM is a leased network of dedicated domestic satellite earth stations at Goddard, White Sands and Hawaii with services configured in a redundant broadcast configuration equipped with a special Multiplexer/Demultiplexer (MDM) Data System now being completed. This system will have data terminals at Goddard, White Sands, and Houston and will become the backbone for providing Tracking and Data Relay Satellite System (TDRSS) data services among these three locations. RCA American Communication, Inc., has been awarded a contract to provide a 50 MBS data service from the White Sands NASA ground terminal to Goddard and to Houston. The service will use a dedicated full satellite transponder in RCA's domestic satellite system and existing earth stations, and provide either 50 MBS, 5.2 MHz analog or television services on a switchable basis.

As was the case during earlier Shuttle activities, NASA will continue to require television coverage from various locations during orbital test flights and later operational missions. Video/audio services will monitor pre-launch and launch activities from Kennedy Space Center, mission activities from tracking sites at Kennedy, Dryden, Goldstone, and Kokee Park. Landing and post-landing activities will be initially covered at Dryden and later at Kennedy Space Center.

All video coverage will be downlinked simultaneously at Kennedy, Johnson, and Goddard, which in turn will distribute the signal to NASA Headquarters in Washington; at Marshall, and to RCA Americom commercial earth stations near New York and Los Angeles for media distribution. Television coverage will also be made available to the media in Houston, Washington, Huntsville, Kennedy and Dryden.

Astronaut safety being a prime consideration, Shuttle support services have been designed for ultimate reliability. The most critical of these services being the wideband data links, where specifications call for 99.95 percent availability, a bit-error rate of 1×10^{-7}, trouble isolation within 20 minutes and service restoration within two hours. Availability specifications require that service downtime not exceed 0.5 percent of operational time or, less than 4.4 hours per year.

NASA's space communications responsibilities by no means are constrained to multi-disciplinary science spacecraft or Shuttle support. STDN and NASCOM planners are busy preparing the worldwide system for such ultrasophisticated satellites as SPACE TELESCOPE and LANDSAT-3, to be orbited in the 83-84 time frame; Telescope via Shuttle, Landsat-D by a Delta 3910 launch vehicle.

Wideband and most high-speed data circuits terminate on conventional patch bays in Technical Control. Circuits scheduled for data transmissions and spacecraft support are configured by personnel who are specifically assigned to Technical Control and under the direction of the shift Communications Manager. When support on circuits is completed, Technical Control personnel terminate the interface at the direction of the Communications Manager or user, as applicable. In addition, unique support configurations are established and failed circuits restored by Technical Control personnel.

Both spacecraft are advanced state-of-the-art designs and represent the ultimate in space research and development. Because of this NASA communications systems both spaceborne and ground based will literally have their "Bands-Full."

For example, principal objective for the Landsat-D will be the testing of the new Thematic Mappers' potential for improving data; system feasability demonstrations to define a future operational system; expanded foreign participation; and the transition from Multi Spectral Scanner data to the higher resolution and data rate of the Thematic Mapper.

The TM, a new sensor which will provide scenes of 30-meter resolution is a seven channel radiometer. The Multi-Spectral Scanner (MSS) will have four channels, and 80 meter resolution. It is essentially the same as those aboard Landsats 1 and 2, but will generate data one order of magnitude faster than the earlier models. This flood of information requires a fully automated Data Management System that will display, record, process and store 100 TM and 200 MSS scenes per day. These data will assist a diverse array of users and scientists in the evaluation of agriculture, land use, environmental assessment, oil exploration and mineral deposit investigations.

Space Telescope takes the opposite view. It is a better research tool whose time has come. It will be placed in orbit by the Space Shuttle and will perform its many functions in an environment impossible to duplicate on Earth. As energy passes through it, our atmosphere filters out most of the electromagnetic spectrum. Thus, until the advent of space probes and orbiting observatories, a large percentage of the information coming from celestial objects was not available to earth-based scientists. The nearby stars, the weather on nearby planets, and the planetary systems on stars 30 or more light years away will be subjected to Space Telescope scrutiny. Since Shuttle carries equipment to manipulate orbiting satellites Space Telescope can be serviced and repaired while in orbit, even new instruments installed. It can also be returned to Earth for major repairs and improvements and then replaced in orbit.

Orbital Flight Test Program

The network for the Orbital Flight Test Program consists of 15 ground stations equipped with 4.3, 9, 12, and 26 meter (14, 30, 40, and 85 feet) S-band antenna systems and C-band radar systems, augmented by 15 Department of Defense geographical locations providing C-band support and one Department of Defense 18.3 meter (60 feet) S-band antenna system. In addition, there are six major computing interfaces located at the Network Operations Control Center (NOCC) and at the Operations Support Computing Facility (OSCF), both at Goddard; Western Space and Missile Center, California; Air Force Satellite Control Facility, Colorado; White Sands Missile Range, New Mexico; and Eastern Space and Missile Center, Florida, providing realtime network computational support.

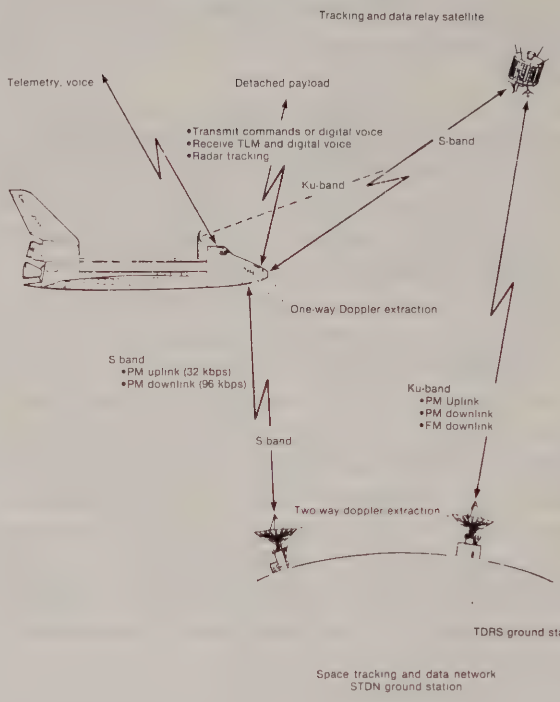
NASA Tracking Stations

Location	Equipment
1. Ascension Island (ACN)	S-Band, UHF A/G
2. Bermuda (BDA)	S-Band, C-Band, UHF A/G
3. Buckhorn (BUC)	S-Band, C-Band
4. Goldstone (GDS)	S-Band, UHF A/G
5. Guam (GWM)	S-Band, UHF A/G
6. Hawaii (HAW)	S-Band, UHF A/G
7. Merritt Island (MIL)	S-Band, UHF A/G
8. Santiago (AGO)	S-Band
9. Madrid (MAD)	S-Band, UHF A/G
10. Orroral (ORR)	S-Band
11. Botswana (BOT)	UHF A/G
12. Dakar (DKR)	UHF A/G
13. Yarragadee (YAR)	UHF A/G

Personnel:
Tracking Stations, 1,110*
Goddard Space Flight Center, 1,400

*More than 500 of which are local residents

ORBITAL COMMUNICATIONS
AND TRACKING LINKS



The network has support agreements with the governments of Australia, Spain, Senegal, Botswana, Chile, United Kingdom and Bermuda to provide NASA tracking stations support to the Space Transportation System program.

In the Spaceflight Tracking and Data Network Operations Control Center at Goddard, the network director and a team of operations managers and network systems specialists, keep the entire network tuned for the mission support. Should the Johnson Space Center Mission Control Center be seriously impaired for an extended time, facilities serving the Network Operations Control Center becomes an emergency mission control center manned by Johnson personnel, with the responsibility of safely returning the Space Shuttle Orbiter to a landing field.

The Merritt Island, Fla., S-band station provides the appropriate data to the Launch Control Center at the Kennedy Space Center and the Mission Control Center at Johnson during prelaunch testing and the terminal countdown. During the first minutes of launch and during the ascent phase, the Merritt Island and Ponce de Leon, Fla., S-band and Bermuda S-band stations, as well as the C-band stations located at Bermuda; Wallops Island, Va.; Grand Bahama; Grand Turk; Antigua; Cape Canaveral; and Patrick Air Force Base, Fla., will provide appropriate tracking data, both high speed and low speed, to the Kennedy and Johnson Control Centers.

The Madrid, Spain; Indian Ocean Stations Seychelles; Orroral and Yarragadee, Australia; and Guam stations provide critical support to the Orbital Maneuvering System 1 and 2 burns on the first revolution. During the orbital phase, all the S-band and some of the C-band stations that see the Space Shuttle Orbiter at 3 degrees above the horizon will support and provide appropriate tracking, telemetry, air-ground and command support to the Johnson Mission Control Center through Goddard.

STS-3 Frequencies

Uplink:	Downlink:
2106 MHz	2205 MHz
1831 MHz	2217 MHz
2041 MHz	2287 MHz
	2250 MHz
296.8 MHz	296.8 MHz
259.4 MHz	259.4 MHz

During the nominal reentry and landing phase planned for Edwards Air Force Base, California; the Goldstone and Buckhorn, California; S-band stations and C-band stations at the Pacific Missile Test Center, Vandenberg Air Force Base, Edwards Air Force Base and Dryden Flight Research Center will provide highly critical tracking, telemetry, command and air-ground support to the Orbiter and send appropriate data to the Johnson and Kennedy Control Centers.

Around the World

By Kaz J. Deskur, K2ZRO*

I would like to bring to the attention of readers the new publication: *QEX ARRL Experiminters Exchange*. *QEX* is primarily intended to serve as a soundboard for state-of-the-art experimenters with novel, progressive, and even avant-garde ideas. It appears that articles to be published in *QEX* will be those that *QST* is reluctant to print because of their limited general interest (for a while), or by being too experimental for mass consumption. What we may expect in future issues are papers dealing with data communications, packet-radio, spread spectrum techniques, adaptation of computers to Amateur Radio, medium-scan TV, applications of newly developed devices, and similar "exotic" and exciting, subjects. An attempt will be made to keep a balance between digital and analog technology. Several permanent columns will be devoted to subjects such as description of recently introduced products, announcements of progressive mini-courses, novel circuits and data communication. The premiere issue, Jan. '82, featured an excellent article by G.H. Krauss WA2GFP on the design of low-noise-figure preamplifiers (LNA). The author provides a very comprehensive listing of available low-noise transistors that included nf, parameters, and recommended input-output biasing circuit configuration for all amateur bands from 30-1296 MHz. The cost of each transistor is also indicated. *QEX* will certainly be of great interest to progressive and future-oriented radio amateurs.

November and December 1981 issues of RSGB's *Rad-Com* bring a two-part article by J. N. Gannaway, G3YGF, under a very long title: "The Effects of a Preamplifier on Receiver Performance, and a review of some currently available 144MHz Preamplifiers." In this very informative paper the author discussed the factors governing the performance of receivers and preamplifiers, such as sensitivity, strong signal performance and dynamic range.

He also assesses the effects of external noise sources, and cable losses. The article explains the necessity of a mismatch of the input for optimization of nf and describes the aligning procedures. The main purpose of the article is to show the compromises involved in using preamplifier/receiver combination in a receiving system. The main conclusions are as follows: Excessive gain of the preamp will degrade the strong signal performance and will reduce the dynamic range. At 144 MHz, the external noise will limit useful nf to about 2 dB and any attempt to improve it will most likely be made at the expense of strong signal performance. The cable losses between the antenna and the preamp add to the overall noise figure. The article is illustrated with several graphs, and includes applicable mathematical equations. The second part brings descriptions and performance assessments of several preamplifiers available in UK. This includes Lunar and Microwave Modules that are also popular in North America.

Although, I felt that more than enough tracking programs have been described in this column already, I could not resist to add one more, because this one is different. March 1982 *73* Magazine published a program, for circularly orbiting satellites, developed by Thomas C. Johnson, WB6NQK, intended for 48 K Apple III Plus with single disk drive. In addition to "conventional" az-el, range, successive EQX...informations, the program allows displaying in color (of sorts) the map of North America and the track of the satellite. The program is very complex, but the duplication time for the intended user can be saved by ordering, from the author, a diskette for $15. (3628 A Court, Oxnard, CA 93033.)

In the past, Jurgen Raddatz, DL3ZK, authored several high-level articles dealing with calculation of earth's shadow passages of satellites and determination of equatorial crossings. Most of his papers, although very informative, would be too difficult to abstract because of their complexity and highly mathematical treatment. One item, however, "Calculations of EQX derived from telemetry informations," is unique and probably very little known among the satellite users. Having the altitude of the satellite and its inclination in addition to a term he calls "the solar time angle" calculated from the Nautical Almanac ahead of time, Jurgen shows how to determine the EQX with an accuracy of only a few seconds. It is only necessary to monitor the beacon's solar-panel current, and to note the time where the current increases abruptly when the satellite emerges from the "dark side" of the earth. Using the above data and a simple mathematical formula allows calculations of the time and the longitude of EQX. The details are described in March 1981 *CQDL*. Also the October 81 issue of RSGBs *Rad-Com* publishes a paper by the same author describing a method for determining the time a satellite spends in the earth's shadow.

**Box 11, Endicott, NY 13760*

Satellite Log

By Geoffrey Falworth*

Satellite Log features launches into orbit since the beginning of 1980. The satellite name is that assigned by the launching agency (the international designation is in parenthesis) and the orbit (period, inclination to Earth's equator, apogee height, perigee height) is for shortly after launch; later maneuvers may modify this orbit. Transmissions are those which are publicly reported or assumed from the type of spacecraft involved.

Operations 3984 (1981-85A) launched on 1981 Sep 3; initial orbit: 92.02 min, 96°.93, 527 km, 217 km; transmissions: none reported. Reconnaissance satellite.

Cosmos 1303 (1981-86A) launched on 1981 Sep 4; initial orbit: 90.23 min, 70°.41, 364 km, 207 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1304 (1981-87A) launched on 1981 Sep 4; initial orbit: 103.99 min, 82°.94, 980 km, 912 km; transmissions: none reported. Military research satellite.

Cosmos 1305 (1981-88A) launched on 1981 Sep 11; initial orbit: 263.73 min, 62°.83, 13865 km, 626 km; transmissions: none reported. Possible Molniya or Cosmos early warning satellite; failed to achieve nominal orbit due to third stage underburn.

Cosmos 1306 (1981-89A) launched on 1981 Sep 14; initial orbit: 93.33 min, 64°.96, 444 km, 431 km; transmissions: none reported. Ocean radar reconnaissance satellite.

Cosmos 1307 (1981-90A) launched on 1981 Sep 15; initial orbit: 92.50 min, 72°.88, 426 km, 377 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1308 (1981-91A) launched on 1981 Sep 18; initial orbit: 104.86 min, 82°.92, 1004 km, 970 km; transmissions: 150.000 MHz. Navigation satellite.

Cosmos 1309 (1981-92A) launched on 1981 Sep 18; initial orbit: 89.23 min, 82°.30, 257 km, 212 km; transmissions: none reported. Recoverable Earth-resources, reconnaissance satellite.

China 9A (1981-93A) launched on 1981 Sep 19; initial orbit: 103.27 min, 59°.41, 1598 km, 232 km; transmissions: none reported. Atmospheric drag research satellite comprising balloon linked to instrumented sphere by cable.

China 9B (1981-93B) launched on 1981 Sep 19; initial orbit: 103.49 min, 59°.47, 1615 km, 235 km; transmissions: none reported. Upper-atmosphere and charge-particle research satellite.

China 9C (1981-93D) launched on 1981 Sep 19; initial orbit: 103.42 min, 59°.47, 1609 km, 234 km; transmissions: none reported. Upper-atmosphere and charged-particle research satellite.

Aureole 3 (1981-94A) launched on 1981 Sep 21; initial orbit: 109.47 min, 82°.50, 1995 km, 406 km; transmissions: 136.000 MHz. French aurora and charged-particle research satellite.

Cosmos 1310 (1981-95A) launched on 1981 Sep 23; initial orbit: 94.56 min, 65°.84, 518 km, 477 km; transmissions: none reported. Radar calibration and test satellite.

Satellite Business Systems 2 (1981-96A) launched on 1981 Sep 24; initial orbit: 1424.48 min, 0°.29, 35626 km, 35498 km; transmissions: 11703.500 to 11746.500, 11752.500 to 11795.500, 11801.500 to 11844.500, 11850.500 to 11893.500, 11899.500 to 11942.500, 11948.500 to 11991.500, 11997.500 to 12040.500, 12046.500 to 12089.500, 12095.500 to 12138.500, 12144.500 to 12187.500 MHz. Commercial data relay satellite to be located over longitude 97° West.

Cosmos 1311 (1981-97A) launched on 1981 Sep 28; initial orbit: 94.46 min, 82°.99, 519 km, 463 km; transmissions: none reported. Military research satellite.

Cosmos 1312 (1981-98A) launched on 1981 Sep 30; initial orbit: 115.99 min, 82°.59, 1505 km, 1493 km; transmissions: none reported. Tactical communications satellite.

Cosmos 1313 (1981-99A) launched on 1981 Oct 1; initial orbit: 89.48 min, 70°.36, 291 km; transmissions: none reported. Recoverable reconnaissance satellite.

Solar Mesosphere Explorer (1981-100A) launched on 1981 Oct 6; initial orbit: 95.46 min, 97°.46, 542 km, 538 km; transmissions: 2287.500 MHz. Upper atmosphere research satellite monitoring Earth's mesosphere.

OSCAR 9 (1981-100B) launched on 1981 Oct 6; initial orbit: 95.46 min, 97°.46, 541 km, 538 km; transmissions: 7.050, 14.002, 21.002, 29.510, 145.825, 435.025, 2401.000 and 10470.000 MHz. University of Surrey (England) amateur scientific satellite.

Cosmos 1314 (1981-101A) launched on 1981 Oct 9; initial orbit: 89.04 min, 82°.28, 235 km, 217 km; transmissions: none reported. Recoverable reconnaissance and Earth resources satellite.

Raduga 10 (1981-102A) launched on 1981 Oct 9; initial orbit: 1436.03 min, 0°.40, 35811 km, 35766 km; transmissions: 3675, 3775, 3875, 7250 to 7750 MHz. Communications satellite at Statsionar 3 location over longitude 85° East.

Cosmos 1315 (1981-103A) launched on 1981 Oct 13; initial orbit: 96.69 min, 81°.19, 667 km, 627 km; transmissions: none reported. Military weather and electronic surveillance satellite.

Cosmos 1316 *(1981-104A) launched on 1981 Oct 15; initial orbit: 90.46 min, 70°.36,* 385 km, 209 km; transmissions: none reported. Recoverable reconnaissance satellite.

Molniya 85 (1981-105A) launched on 1981 Oct 17; initial orbit: 718.42 min, 62°.81, 39774 km, 617 km; transmissions: 3650 to 3700 MHz, 3750 to 3800 MHz, 3850 to 3900 MHz. Molniya 3-class communications satellite.

Venus 13 (1981-106A) launched on 1981 Oct 30; initial orbit: heliocentric orbit; transmissions: 928.400 MHz. Venus orbiter and lander spacecraft.

Operations 4029 (1981-107A) launched on 1981 Oct 31; initial orbit: 1436.18 min, 0°.10, 35801 km, 35782 km; transmissions: none reported. Early warning and surveillance satellite.

Cosmos 1317 (1981-108A) launched on 1981 Oct 31; initial orbit: 718.09 min, 62°.89, 39789 km, 585 km; transmissions: 2292 MHz. Early warning satellite.

Cosmos 1318 (1981-109A) launched on 1981 Nov 3; initial orbit: 89.75 min, 67°.14, 353 km, 172 km; transmissions: none reported. Recoverable reconnaissance satellite.

Venus 14 (1981-110A) launched on 1981 Nov 4; initial orbit: heliocentric orbit; transmissions: 928.400 MHz. Venus orbiter and lander spacecraft.

STS 2 (1981-111A) launched on 1981 Nov 12; initial orbit: 88.83 min, 38°.03, 227 km, 218 km; transmissions: 2205.000, 2217.500, 2250.000, 2287.500 MHz. OV-102 Columbia in second Orbital Flight Test carrying Office of Space and Terrestrial Applications pallet 1.

Cosmos 1319 (1981-112A) launched on 1981 Nov 13; initial orbit: 90.38 min, 70°.36, 377 km, 209 km; transmissions: none reported. Recoverable reconnaissance satellite.

Molniya 86 (1981-113A) launched on 1981 Nov 17; initial orbit: 718.58 min, 62°.80, 39035 km, 466 km; transmissions: 800 to 1000 MHz, 3400 to 4100 MHz. Molniya 1-class communications satellite.

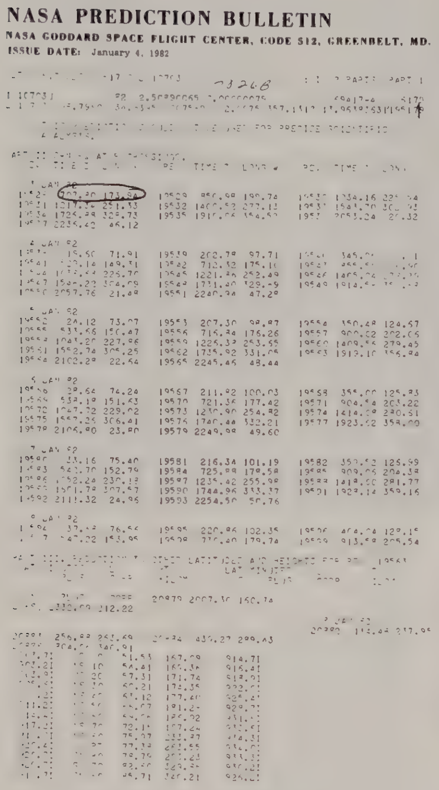
RCA Satcom 3R (1981-114A) launched on 1981 Nov 19; initial orbit: 1436.08 min, 0°.14, 35797 km, 35782 km; transmissions: 3701.000, 3703 to 3737, 3723 to 3757, 3743 to 3777, 3763 to 3797, 3783 to 3817, 3803 to 3837, 3823 to 3857, 3843 to 3877, 3863 to 3897, 3883 to 3917, 3903 to 3937, 3923 to 3957, 3943 to 3977, 3963 to 3997, 3983 to 4017, 4003 to 4037, 4023 to 4057, 4043 to 4077, 4063 to 4097, 4083 to 4117, 4103 to 4137, 4123 to 4157, 4143 to 4177, 4163 to 4197, 4199.000 MHz. Commercial communciations satellite over longitude 131° West.

Bhaskara 2 (1981-115A) launched on Nov 20; initial orbit: 95.20 min, 50°.64, 542 km, 520 km; transmissions: 136.430 MHz. Soviet-launched Indian Earth resources satellite.

*12 Barn Croft, Penwortham, Preston PR1 OSX

Program and Printout Details for Orbit Calculations

(from page 16)



NASA PREDICTION BULLETIN

NASA GODDARD SPACE FLIGHT CENTER, CODE 512, GREENBELT, MD.

ISSUE DATE: January 4, 1982

(Continued on page 32)

High Performance

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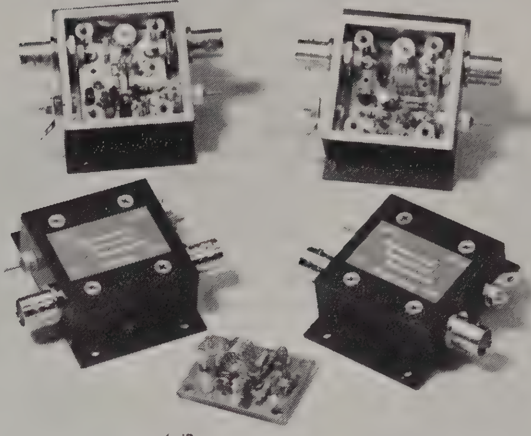

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	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
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P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+ 12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+ 12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+ 12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	– 20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	– 20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+ 12	GaAsFET	$79.95

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Preamps are available without case and connectors: subtract $10. Other preamps available in the 1 - 800 MHz range. Prices shown are postpaid for U.S. and Canada. CT residents add 7-½% sales tax. C.O.D. orders add $2. Air mail to foreign countries add 10%.

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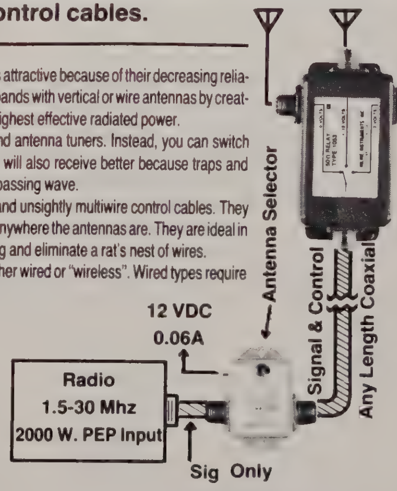
With INLINE "wireless" weatherproof coaxial relays you simply add more antennas without costly control cables.

For years to come sun spot activity will make 10, 15 and 20 meters less attractive because of their decreasing reliability. You can enjoy long distance and reliable operation on the lower bands with vertical or wire antennas by creating simple 2 element arrays. Remember—efficient antennas create highest effective radiated power.

Avoid wasting RF power and radiating efficiency using band traps and antenna tuners. Instead, you can switch antennas and get up to 10db more signal into that distant point. You will also receive better because traps and antenna tuners do not provide an effective signal gathering area to a passing wave.

INLINE relays can be installed virtually anywhere without expensive and unsightly multiwire control cables. They can be placed in the attic, on the roof, on a mast, on a tree, on a tower, anywhere the antennas are. They are ideal in apartment houses to overcome restrictions. They minimize hole drilling and eliminate a rat's nest of wires.

INLINE relays are available in two position and three position types, either wired or "wireless". Wired types require 1 conductor + ground.



Two position relays
Type 101A - DC to 180 MHz - $32.95 - Wired
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Type 108* - 25 to 970 MHz - $74.95 - Wireless

Three position relays
Type 1013 - DC to 180 MHz - $49.95 - Wired
Type 1053/105C - 1.5 to 180 MHz - $79.95 - Wireless

Type 1053/105C Illustrated

Other types, all frequencies available. Relay power ratings decrease with increasing frequency. See literature for detailed chart

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Amsat News...

(Continued from page 21)

New Net Voices On Tap

AMSAT Net Manager, Wray Dudley, W8GQW, has announced two additions to the NCS roster. The new stations are W1KK, Art Zavarella, of Agawam, MA and N3AR, Ron Schwendt, of Douglassville, PA. These individuals will be integrated in the rotation for the weekend 20 and 15 meter AMSAT International Net on Sundays. Watch for them soon and welcome aboard to both our new NCS!

WD0EEL, left and W8GQW exchange views during the 1982 Dayton Hamvention.

Calendar Updates

Latest correction factors to the Project OSCAR orbital prediction calendar are given as follows calculated for 1 Aug. 82:
(Please add the following values to the times given in the tables)
AO-8, +116; RS-3, +39; RS-4, +14; RS-5, −68; RS-6, −7, RS-7, +28; RS-8, +27.

All values are time in seconds to be added.

UoSAT-OSCAR 9 reference orbit for 1 Aug.: 00:05:47 at 135.6 W.

Differentials are computed based on latest NASA observations.

W4BE Wins "Chicken Little" Contest

Buzz Eggebrecht, W4BE, of Port Richey, Florida has won the "Chicken Little" contest by most accurately predicting the fall from orbit of ISKRA-2.

Buzz's winning guess was off by −5.00 hours but was good enough to win him the prize of a brand new 70 cm crossed Yagi antenna. Buzz's entry was postmarked 1 July 82, AM, and his guess was 8 July, 19:19:19 UTC. The actual deorbit time was given by official sources consulted by AMSAT as 00:19 UTC, 9 July. (The actual time given was a window in which 00:19 was the center, most likely time of occurrance.) Thus Buzz's entry was nearly exactly 5 hours off. Note the preponderance of "19s" in the guess and the correct time! Buzz probably worked the hardest of any of the entries filing no fewer than 13 guesses between 1 July and 13 July. He won, however, with his very first entry!

A close second was scored by Ed Koskie, N2EK, of Kingston, New York. Ed's guess of 0600 UTC, 9 July missed by +5.68 hours. Other close guesses were filed by Stan Moffatt, ZL3CU, 3rd place, −6.22 hours; Don, W1YCW, 4th place, +11.20 hours; Joe, N1BGA, 5th placed, −22.78 hours.

The first report of ISKRA-2 telemetry loss came from PA0DLO who reported not hearing ISKRA-2 on 10 July when expected. Nico commented at the time that he thought ISKRA had a few more days since the period of the orbit was at that time about 88 minutes. Most experts expected the orbit decay to occur when the orbital period approached 86 minutes. Apparently the slide from 88 to 86 or 85 was much, much quicker than had been predicted. Other reports later filtered into AMSAT confirming that 9 July had been the date of last observation of the satellite's beacon. It was not clear until last week that the satellite had decayed from orbit concurrent with the loss of telemetry reported to have occurred on the 9th. In fact, AMSAT officials had cautioned against concluding absolutely that both telemetry loss and decay had been concurrent since the period on the 9th was well above the lowest period thought to be sustainable for a matter of days. A reasonable alternate hypothesis was offered which suggested that atmospheric heating associated with the increased velocity of ISKRA-2 had caused the telemetry failure. It now seems clear that the interval between beacon failure due to atmospheric heating and actual decay of the orbit was measured in seconds and minutes rather than hours and perhaps days as had been speculated based on the 88 minute period at that time.

Some of the most interesting data submitted, although it did not comprise an official contest entry, came from our colleagues in Japan. A team comprised of JA7IE, JR2DBE, J2WO and led by JR2BQN provided graphs depicting period versus orbit number and height versus orbit number. The graphs clearly show the exponential nature of the orbital decay function. Moreover, the team cites orbit #840 as the exact orbit in which decay occurred. We have not confirmed this as fact but JR2BQN's team seems to have made a case for #840 as being ISKRA's last go-round. AMSAT especially congratulates Mr. Rikizo Imaizumi, JR2BQN, and his team for the exceptional manner of their research. Although not entered in the contest, these individuals clearly participated in the spirit of the contest, that is, the application of space science techniques to amateur radio satellites.

ORBIT congratulates W4BE and all entries in this fun contest.

AMSAT Speakers Featured At ARRL Event

AMSAT and amateur satellite activities were on display 23-26 July in Cedar Rapids, Iowa at the ARRL National Convention. The three-day event brought together thousands of amateurs from around the nation and dozens of the leaders of the amateur radio community. The ARRL Directors had met for the previous four days at the Five Seasons Center in downtown Cedar Rapids.

AMSAT was well-represented by a contingent of East-coast HQ delegates as well as prominent AMSAT managers from the midwest. AMSAT Iowa Area Coordinator Ralph Wallio, W0RPK, did a first-rate, professional job in organizing the AMSAT activities, setting up the booth, lining up the materials and generally insuring things ran according to plan. Ralph's superb efforts resulted in the entire weekend coming off without a single hitch!

Heading up the AMSAT HQ contingent was President Tom Clark, W3IWI. Tom was featured speaker at Sunday's satellite seminar session. Executive Vice President Vern "Rip" Riportella, WA2LQQ, attended the convention wearing all three of his official caps: VP, *Orbit* Editor and *ASR* Editor! Jim McKim, W0CY, AMSAT's Chief Area Coordinator, joined in making the event a memorable one. Jim is one of the veterans of AMSAT and since his recent retirement has upgraded his participation. Jim is also NCS for the Mid-America 75 meter AMSAT net on Wednesdays (UTC). Colorado Area Coordinator Bill McCaa, K0RZ, did yeoman duty at the booth and his Apple computer satellite tracking program was a real eye-catcher and conversation piece.

The major draw of the weekend for satellite afficianados was the three-hour AM-

SAT forum beginning at 9:00 AM Sunday morning. W0RPK led off the program with beginner-level topics using slides and viewgraphs to illustrate his talk. Following W0RPK, K0RZ spoke on how he managed to automate his station using his Apple computer to track the satellites by automatically pointing the antennas, switching the rigs on and generally preparing things for a QSO. Bill explained how his efforts at auto-Doppler correction were frustrated by erratic operating procedures of "normal," human operated stations. Finally, W3IWI presented a set of intriguing slides on the Phase III program. Many of the slides had not previously been seen in public and were the subject of intense interest from the audience which numbered between 80 and 90. Tom's slides featured all of the Phase IIIB hardware, many of the builders of the bird and some interesting slides of the recent thermal vacuum testing of Phase IIIB. A question and answer period followed.

The booth traffic was brisk with many fellow AMSAT members stopping by to chat and exchange views and reminiscences. Dozens of satellite folk came to the booth to meet the staff and to discuss their feelings on AMSAT-related issues.

ORBIT congratulates W0RPK, W3IWI, K0RZ on a job well-done. To the booth crew including W4DAQ, K0CY, W0RUE and others, thanks. *ORBIT* extends especially warm thanks to W0YZC for his hospitality! And to all the ARRL Directors who came by the booth to express support, our continued appreciation. A special note of thanks to W1QV for his superb efforts in AMSAT's behalf. Vy FB indeed!

Recent AMSAT Appointments

AMSAT Headquarters announced recently the following appointments. W2HG, Bob Rossi, has been appointed Area Coordinator for Western New York. Bob had previously coordinated the Satellite User's list for the Callbook. W2FPY and crew picks up this task. The following named individuals have been appointed Assistant Area Coordinators for the areas indicated: WB5PMR, Allen Brinkerhoff, for North Texas; W0VO, Ed Means, for Colorado; W3HV, Bill Clepper, Western Pennsylvania. An Area Coordinator for the State of Arkansas is needed following the relocation of WB5KIE out of the state. In Canada, VE4NI, Don Campbell, has been appointed Area Coordinator for Winnipeg.

N6TE, Harry Bluestein, of LaJolla, California has volunteered to assist with the West Coast 75 meter net.

Congratulations and thanks to the new volunteers/appointees!

Anglo-Yank J-DX Claim

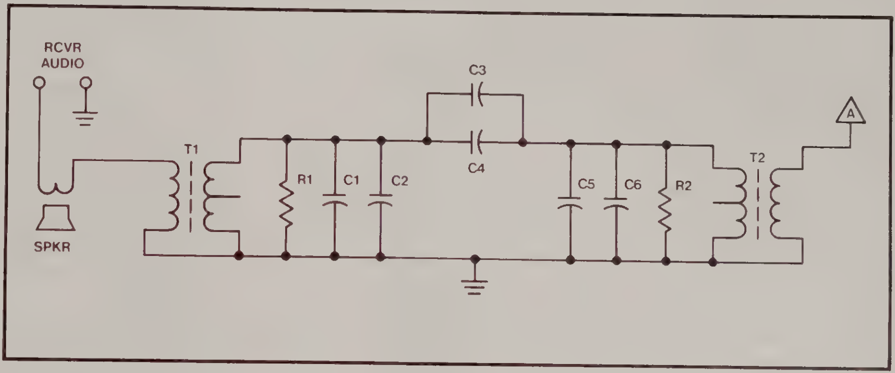
Citing a mutual visibility window of less than 30 seconds, two stations have laid claim to a new AO-8, Mode J DX record. On one end of the circuit was veteran DXer and European AMSAT Coordinator Pat Gowen, G3IOR. At the other end was the now well-known Lexington, Kentucky station of Bill Maxson, N4AR. Other claims to the all-time record including QSO's involving G6ADC, G4CUO, W4AUZ and WH6AMX appear to have been upstaged a bit by the 31 July N4AR-G3IOR QSO which occurred by sked at 11:11 UTC. G3IOR resides in Norwich, Norfolk on the eastern coast of England. Depending on what means are employed for determinations, there may be between −1.0 to +1.0 minutes of mutual visibility between Lexington and Norwich. In any case these two "pros" have now apparently closely approached the real limit of non-enhanced Mode J DX!

The W6HDO Demodulator Circuit

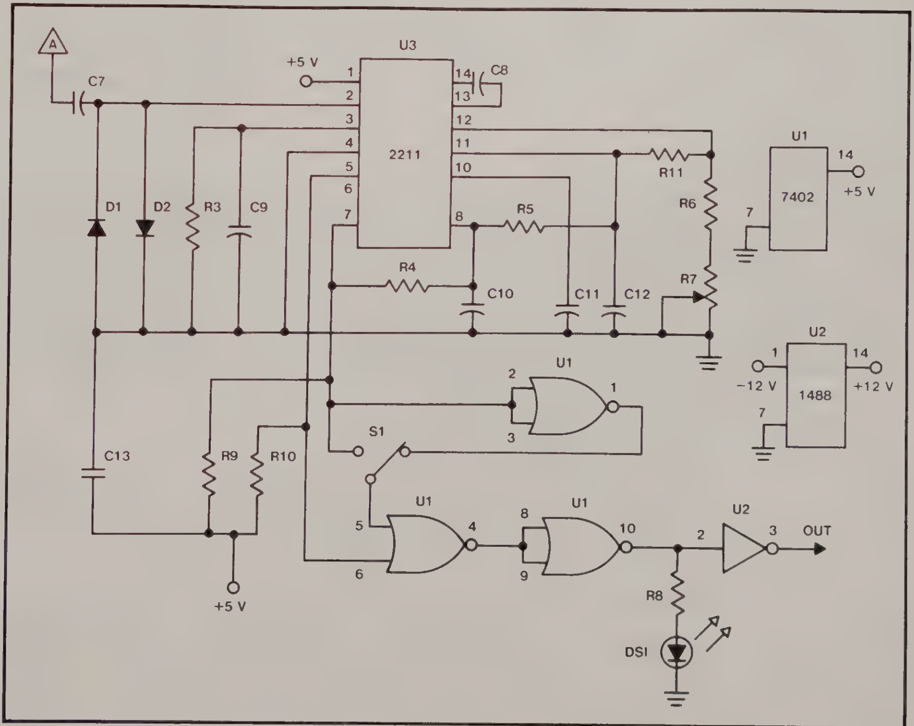
In anticipation of the day when UoSAT-OSCAR 9 is extricated from its present dilemma, *ORBIT* herewith reprints the corrected demodulator circuit which first appeared in *ORBIT* No. 10. Part numbers given after component designations refer to Radio Shack unless otherwise noted.

R1, R2 - 22k (271-1339)
R3 - 330k
R4 - 510k
R5 - 100k (271-1347)
R6 - 15k (271-1337)
R7 - 10k (10-turn precision pot. preferred)
R8 - 1k (271-1321)
R9, R10 - 10k (271-1335)
R11 - Any temperature stable resistor between 33k and 36k.
C1, C5 - .047 (272-1068)
C2, C4, C6 - .01 (272-1065)
C3 - 0.68
C7, C11, C13 - 0.1 (272-1415) Connect C13 between +5V and ground.
C8 - .027 poly or mylar
C9 - 0.47 mylar (272-1054)
C10 - .0025 poly*
C12 - .001 poly*
U1 - 7402 (276-1811)
U2 - 1488
U3 - Exar (Raytheon) 2211
D1, D2 - 1N4001 (or 276-1122)
DS1 - LED (276-041)
S1 - Switch (275-407)

*These can be comprised of two or more parallel units.



The W6HDO filter circuit is shown above. Below is the revised demodulator schematic diagram for those interested in working with UoSAT/OSCAR 9 should it be restored to working order. Keep tuned to AMSAT Nets and watch *AMSAT Satellite Report* for the operational status of this satellite.



"Earthorbit" Printout

```
10  REM  EARTHORBIT 1.0
10000  HOME : PRINT : PRINT "EARTH SATELLITE ORBIT PREDICTION PROGRAM"
10002  PRINT : PRINT "    BY WINSTON GORE"
10004  PRINT : PRINT "A SIMPLIFIED PROGRAM FOR": PRINT "   TEACHING PURPOS
       ES."
10006  VTAB 10: PRINT "BASED ON A PROGRAM BY TOM CLARK": PRINT "   AND BIL
       L GORE"
10007  PRINT : PRINT "CALCULATED FROM DATA IN PROGRAM TEXT"
10008  VTAB 15: PRINT "PRESS RETURN TO RUN...": GET C$
10010  GOSUB 40000: REM  LOAD PHYSICAL DATA
10020  GOSUB 41000: REM  LOAD TIME DATA, UNIVERSAL TIME
10030  GOSUB 42000: REM  INITIALIZE FOR ORBIT
10040  GOSUB 43000: REM  PREPARE ROTATION MATRIX, MW
10045  HOME : VTAB 5: PRINT N$: PRINT : PRINT "ORBIT #     LATITUDE      LO
       NGITUDE": PRINT
10050  FOR T = TT TO T8 + (T9 * .5) STEP T9
10060  GOSUB 44000: REM  MEAN ANOMALY
10070  GOSUB 45000: REM  ECCENTRIC ANOMALY VIA KEPLER'S EQN
10080  GOSUB 46000: REM  TRUE ANOMALY IN RECTANGULAR COORDS
10090  GOSUB 47000: REM  ROTATE TO CELESTIAL COORDINATES
10100  GOSUB 48000: REM  TO GEOCENTRIC COORDS
10110  PRINT K;             ; INT (L5);              ; INT (W5)
10120  NEXT
10130  END
40000  REM  LOAD DATA
40010  REM  PHYSICAL CONSTANTS
40020 P1 = 3.141592653:P0 = P1 / 180:P2 = 2 * P1: REM  RADIANS VS DEGREES

40030 R0 = 6378.16: REM  EARTH RADIUS
40040 G0 = 7.5369793E + 13: REM  CONSTANT FOR ORBIT SIZE
40050 G1 = 1.0027379093: REM  SIDERIAL SOLAR
40060 G2 = 0.2753326721: REM  SIDERIAL TIME IN DAYS SINCE JAN 0.0
40070 KG = 3.14529E10: REM  GRAVITATION CONSTANT IN KM
40080  REM  SATELLITE REF EPOCH DATA FROM NASA BULLETIN
40085 N$ = "OSCAR 8"
40100 D3 = 2.50690065: REM  REF EPOCH DAY
40110 K0 = 19517: REM  REF EPOCH ORBIT #
40120 M0 = 357.1316: REM  REF EPOCH MEAN ANOMALY
40130 N0 = 13.96363631: REM  REF EPOCH MEAN MOTION
40140 I0 = 98.7960: REM  REF EPOCH INCLINATION IN DEGREES
40150 E0 = 0.0007589: REM  REF EPOCH ECCENTRICITY IN DEGREES
40160 W0 = 2.3975: REM  REF EPOCH ARG PERIGEE IN DEGREES
40170 O0 = 34.8395: REM   REF EPOCH RAAN IN DEGREES
40180  RETURN
41000  REM  ENTER TRACKING TIME DATA
41010  REM  BEGIN TRACKING YR, MONTH, DAY
41020 Y = 1982
41022  HOME : VTAB 5: PRINT "YEAR IS: ";Y: INPUT "        MONTH (1-12): ";M:
       INPUT "      DAY: ";D
41030 Y = Y / 100:Y = INT (100 * (Y - INT (Y)) + 0.1)
41040  IF Y / 4 = INT (Y / 4) THEN F5 = 1: REM  LEAP YR FLAG
41050  RESTORE : FOR I = 1 TO M: READ D9: NEXT
41060 D8 = D + D9:D8 = D8 + F5
41070  REM  BEGIN TRACKING. HR, MIN UT
41080  HOME : PRINT : PRINT "   UNIVERSAL TIME TO BEGIN TRACKING.."
41082  PRINT : INPUT " HOUR: ";H: INPUT " MIN: ";M
41090 TT = D8 + H / 24 + M / 1400: REM  BEGIN TRACKING. DAYS SINCE 1/0.0
41100  REM  TRACKING DURATION - HRS, MINS
41110  PRINT : PRINT "     TRACKING DURATION..."
41112  PRINT : INPUT " HOURS: ";H1: INPUT " MINS: ";M1
41120 T8 = TT + H1 / 24 + M1 / 1440: REM  END TRACKING TIME
41130  REM  MINS BETWEEN TRACKING POINTS
41140  PRINT : INPUT "MINUTES BETWEEN ORBIT POINTS: ";M2
41150 T9 = M2 / 1440: REM  TRACKING TIME INCREMENTS IN DAYS
41160 T0 = D3: REM  REFERENCE EPOCH BEGINNING TIME
41170  RETURN
42000  REM  INITIALIZE
42010 A0 = ((G0 / (N0 * N0)) ^ (1 / 3))
42020 N6 = N0 + [illegible]
42030 E0 = E0 * P0:I0 = I0 * P0: REM  TO RADIANS
42040 E2 = 1 - E0 * E0:E1 = SQR (E2):FG = A0 * E1
42050 O = O0:O = O * P0: REM  NO CORRECTION FACTOR
42060 W = W0:W = W * P0: REM  NO CORRECTION FACTOR
42070 Q0 = M0 / 360 + K0: REM  # ORBITS FROM LAUNCH TO REF EPOCH
42080  RETURN
43000  REM  PREPARE ROTATION MATRIX
43010 AZ = O: GOSUB 53000: REM  YIELDS ZR
43020 AX = I0: GOSUB 52000: REM  YIELDS XR
43030  FOR JJ = 1 TO 3: FOR KK = 1 TO 3:MU(JJ,KK) = ZR(JJ,KK):MV(JJ,KK) =
       XR(JJ,KK): NEXT KK: NEXT JJ
43040  GOSUB 50000: REM  XR*ZR
43050 AZ = W: GOSUB 53000: REM  YIELDS ZR
43060  FOR JJ = 1 TO 3: FOR KK = 1 TO 3:MU(JJ,KK) = ZR(JJ,KK):MV(JJ,KK) =
       MW(JJ,KK): NEXT KK: NEXT JJ
43065  GOSUB 50000
43070  RETURN
44000  REM  CALCULATE MEAN ANOMALY
44010 Q = Q0 + N0 * (T - T0): REM  TOTAL # ORBITS SINCE LAUNCH
44020 K =  INT (Q): REM  ORBIT # AT TIME T
44030 M = (Q - K) * P2: REM  MEAN ANOMALY FOR THIS ORBIT, IN RADIANS
44040  RETURN
45000  REM  KEPLER'S EQN
45010 E = M + E0 *  SIN (M) + 0.5 * (E0 * E0) *  SIN (2 * M)
45020 S3 =  SIN (E):C3 =  COS (E):R3 = 1 - E0 * C3:M1 = E - E0 * S3
45030 M5 = M1 - M: IF  ABS (M5) < 1E - 07 THEN 45050
45040 E = E - E5 / R3: GOTO 45020
45050  RETURN
46000  REM  TRUE ANOMALY
46010 X0 = A0 * ( COS (E) - E0)
46020 Y0 = FG *  SIN (E):Z0 = 0
46030  RETURN
47000  REM  ROTATE
47010 IN(1) = X0:IN(2) = Y0:IN(3) = Z0: REM  ROW VECTOR
47020  GOSUB 51000: REM  ROW VECTOR * ROTATION MATRIX
47030 X1 = UT(1):Y1 = UT(2):Z1 = UT(3): REM  ORBIT POINT IN CELESTIAL COOR
       DS
47040  RETURN
48000  REM  TO GEOCENTRIC
48010  REM  FIRST SIDERIAL TIME CONVERSION
48020 G7 = T * G1 + G2:G7 = (G7 -  INT (G7)) * P2
48030  REM  NOW TO ROTATE FOR CORRECT TIME
48040 S7 =  -  SIN (G7):C7 =  COS (G7)
48050 X = (X1 * C7) - (Y1 * S7)
48060 Y = (X1 * S7) + (Y1 * C7):Z = Z1
48070  REM  NOW FOR EARTH SURFACE COORDS
48080 R = A0 * R3
48090 BX = X:BY = Y: GOSUB 54000:W5 = 360 - FA / P0
48100 B5 = Z / R:L5 =  ATN (B5 / ( SQR (1 - B5 * B5))) / P0
48110  RETURN
50000  REM  MATRIX * MATRIX
50010  REM  INPUT MU(3,3), MV(3,3)
50020  REM  OUTPUT MW(3,3)
50030  REM  LOCAL VARIABLES IZ, JZ, KZ
50040  REM  I: ROW; J: COLUMN
50050  FOR IZ = 1 TO 3: FOR JZ = 1 TO 3:MW(IZ,JZ) = 0: NEXT JZ: NEXT IZ
50060  FOR IZ = 1 TO 3
50070  FOR JZ = 1 TO 3
50080  FOR KZ = 1 TO 3
50090 MW(IZ,JZ) = MW(IZ,JZ) + (MU(IZ,KZ) * MV(KZ,JZ))
50100  NEXT KZ
50110  NEXT JZ
50120  NEXT IZ
50130  RETURN
51000  REM  ROW VECTOR * MATRIX
51010  REM  INPUT IN(3) VECTOR AND MW(3,3) MATRIX
51020  REM  OUTPUT UT(3) VECTOR
51030  REM  LOCAL VARIABLES JZ, KZ
51040  FOR JZ = 1 TO 3:UT(JZ) = 0: NEXT JZ
51050  FOR JZ = 1 TO 3
51060  FOR KZ = 1 TO 3
51070 UT(JZ) = UT(JZ) + (IN(KZ) * MW(KZ,JZ))
51080  NEXT KZ
51090  NEXT JZ
51100  RETURN
52000  REM  LOAD XR(3,3)
52010  REM  FOR ROTATION AROUND X-AXIS
52020  REM  INPUT ANGLE AX IN RADIANS
52030 X0 = A0 * ( COS (E) - E0)
52040  REM  OUTPUT XR(3,3)
52050 XR(1,1) = 1:XR(1,2) = 0:XR(1,3) = 0
52060 XR(2,1) = 0:XR(2,2) =  COS (AX):XR(2,3) =  SIN (AX)
52060 Y0 = FG *  SIN (E)
52080 XR(3,1) = 0:XR(3,2) =  -  SIN (AX):XR(3,3) =  COS (AX)
52090  RETURN
52100 Z0 = 0: RETURN
53000  REM  LOAD ZR(3,3)
53010  REM  FOR ROTATION AROUND Z-AXIS
53020  REM  INPUT ANGLE AZ IN RADIANS
53030  REM  OUTPUT ZR(3,3)
53040 ZR(1,1) =  COS (AZ):ZR(1,2) =  SIN (AZ):ZR(1,3) = 0
53050 ZR(2,1) =  -  SIN (AZ):ZR(2,2) =  COS (AZ):ZR(2,3) = 0
53060 ZR(3,1) = 0:ZR(3,2) = 0:ZR(3,3) = 1
53070  RETURN
54000  REM  ARCTAN SIGN CORRECTION
54010  IF BX < 0 THEN FA = P1 +  ATN (BY / BX): RETURN
54020  IF BX > 0 THEN 54050
54030  IF BY >  = 0 THEN FA = P1 / 2: RETURN
54040 FA = 3 * P1 / 2
54050  IF BY >  = 0 THEN FA =  ATN (BY / BX): RETURN
54060 FA = P2 +  ATN (BY / BX)
54070  RETURN
55000  REM  DATA FOR LEAP YEAR CALCULATION
55010  DATA  0,31,59,90,120,151,181,212,243,273,304,334,365
```

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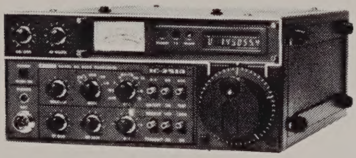

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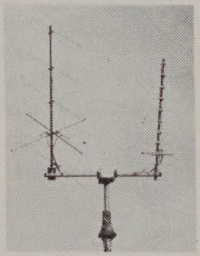

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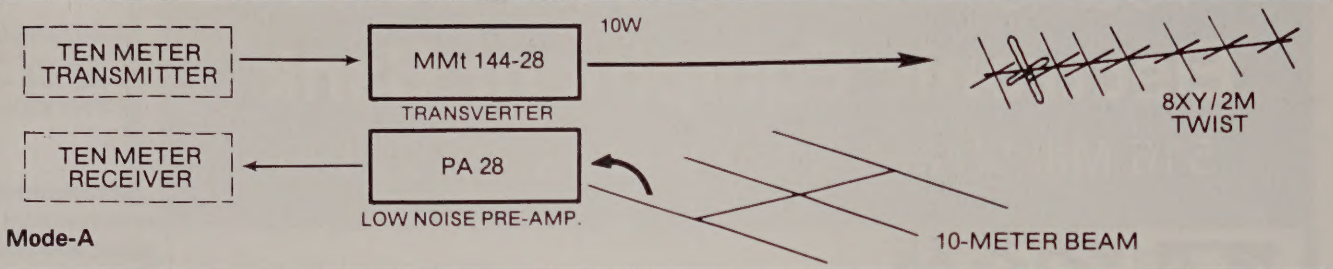
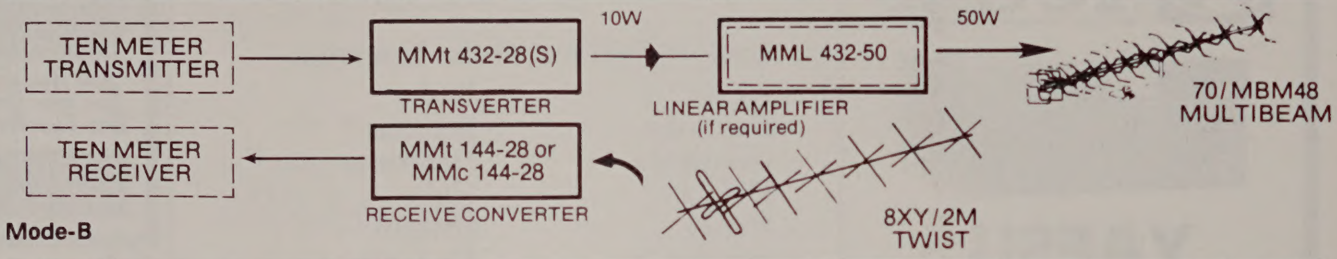
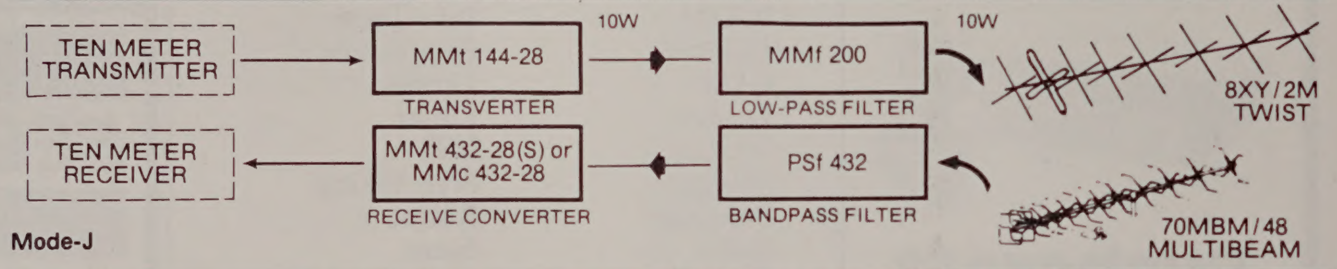


Mode-A



Mode-B



Mode-J

CONVERTERS AND TRANSVERTERS FOR

OSCAR 7
OSCAR 8
PHASE III

Specifications:
Output Power: 10W.
Receiver N.F.: 3 dB typ.
Receiver Gain: 30 dB typ.
Prime Power: 12 Vdc

Receive Converters

MMc 144	$59.95
MMc 432-28(s)	$81.50
MMc 432-28(TC)	$79.95

UHF Filters:

MMf 200-5	$31.95
MMf 200-7	$42.95
PSf 432	$59.95

Receive Preamplifier:
PA-28 $35.95

Mod. kit to adapt original MMt 432-28 FOR Mode-J operation: $26.50

Transverters by Microwave Modules and other manufacturers can convert your existing low-band rig to operate on the VHF and UHF bands. Models also available for 2M to 70 Cm and for ATV operators from Ch2/Ch3 to 70 Cm. Each transverter contains both a Tx up-converter and an Rx down-converter. Write for details of the largest selection available.

Attention owners of the original MMt 432-28 models: Update your transverter to operate OSCAR 8 and Phase III by adding the 434 to 436 MHz range. Mod. kit including full instructions is $26.50 plus $1.50 shipping.

ANTENNAS

2-Meter 8 + 8 Twist Model 8XY/2M	$57.75
Phasing Harness Model PMH/2C	$12.35
48 el. 70 Cm Multibeam Model 70-MBM-48	$75.75
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Oscillator Filters/Crystal Filters • UHF Converters

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Spectrum
International, Inc.
Post Office Box 1084R
Concord, Mass. 01742, USA

Lunar's transverter modules put you here!

Adding various combinations of Lunar's transverter modules to your present station greatly expands your capabilities to: work an Oscar including Phase III; receive noise from the sun for solar flare investigation or for plotting galactic noise sources; receive weather satellite transmission ; or practically anything else found on HF through UHF.

Our transverter modules are distinctly different from the usual transverter or the home built transverter module. With the single band transverter you must purchase a different unit for each additional band you wish to cover.

Lunar's transverter modules, on the other hand, start with the basic down converter for receive and up converter for transmit. Selecting an appropriate local oscillator module determines the band. Additional modules are added to achieve desired receiving NF and/or output power. Changing the local oscillator module changes the band. Pre amps you already have or might build may be used as desired, similarly, for the transmit side.

It's easier than building your own modules from scratch, and costs much less than buying a complete transverter for each additional band.

Some examples of expected performance using Lunar modules.

EXAMPLE 1

Selected modules:
DC 28
LO 28/144
UC-VHF
PAD 144
PAM 144

This combination gives you:
RF: 144 to 146MHz
IF: 28MHz to 30MHz
Conversion Gain: 25dB
Overall NF: 2 dB nom. 1.6 dB typical
Image Rejection: –30 dB typical
LO Purity: –50 dB max. all spurs & harmonics
Drive 28MHz: 1 to 5 mW
Power Output: 20 watts min.
Operating Voltage: 24VDC @ 2.5 amps. nom.

EXAMPLE 2

Modules added to Ex. 1
LO 28/220/222
PAM 220
PAD 220

This gives you:
RF: 220-222, 222-224MHz
Conversion Gain: 22 dB
Overall NF: 2.5 dB typ., 2.2 nom.
Other specs. remain the same.

If you have a specific band you'd like to cover, write or call us and we'll be happy to discuss it with you. Or send for our literature on transverter modules.

LUNAR electronics®

2785 Kurtz Street #10
San Diego, CA 92110
(714) 299-9740 TELEX: 181 747

Louis N. Anciaux
WB6NMT

Watt's new...on 2 meters?

All mode (FM/SSB/CW) POWER, plus...!!!

TR-9130

The TR-9130 is a powerful, yet compact, 25 watt FM/USB/LSB/CW transceiver providing increased versatility of operation on the two meter band. It features six memories, memory scan, memory back-up capability, automatic band scan, all-mode squelch, and CW semi break-in. Available with a 16-key autopatch UP/DOWN microphone (MC-46), or a basic UP/DOWN microphone.

TR-9130 FEATURES:

- **25 watts RF output**
  All modes. (FM/SSB/CW), utilize a new high power linear module, for more reliable FM operation and increased DX on SSB or CW.
- **FM/USB/LSB/CW all mode operation**
  For added convenience in all modes of operation, the mode switch, in combination with the digital step (DS) switch, determines the size (100-Hz, 1-kHz, 5-kHz, 10-kHz) of the tuning or scanning step, and the number of digits displayed.
- **Six memories**
  On FM, memories 1 through 5 for simplex or ±600-kHz offset, with the OFFSET switch. Memory 6 for non-standard offset. All six memories may be operated simplex, any mode.
- **Memory scan**
  Scans memories in which data is stored.
- **Internal battery memory back-up**
  With 9 volt Ni-Cd battery installed, (not Kenwood supplied), memories will be retained approximately 24 hours, adequate for the typical move from base to mobile. A terminal is provided on the rear panel for connecting an external back-up supply.
- **Automatic band scan**
  Scans within selected whole 1-MHz segments (i.e., 144.000-144.9999-MHz).
- **Dual digital VFO's**
- **Repeater reverse switch**
- **Transmit frequency tuning for OSCAR operations**
- **16-key autopatch UP/DOWN microphone version**
- **Squelch circuit on all modes (FM/SSB/CW)**
- **Tone switch**
- **CW semi break-in circuit with sidetone**
- **Digital display with green LED's**
- **High performance receive-transmit design**
  A low-noise dual-gate MOSFET plus two monolithic crystal filters in the receiver front-end results in excellent two signal characteristics. Care in transmitter design assures clean signals in all modes.
- **Compact size and light weight**
  170 (6-11/16) W x 68 (2-11/16) H x 241 (9-1/2) D mm (inch), 2.4 kg (5.3 lbs.).
- **Extended frequency range**
  Covers 143.9 to 148.9999 MHz.
- **Transmit offset switch**
- **High performance noise blanker**
- **RF gain control**
- **RIT circuit for SSB/CW**
- **Amplified AGC**
- **HI/LOW power switch**
  Selects 25 or 5 watts on FM or CW.
- **Accessory terminal**
- **Quick release mounting bracket**

Optional accessories for TR-9130, TR-9500:

- KPS-7 Fixed station power supply
- PS-20 Fixed station power supply (TR-9500 only)
- BO-9A System base with memory back-up supply
- SP-120 External speaker
- TK-1 AC adapter for memory back-up

More information on the TR-9130 and TR-9500 is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220

TR-9500

70 CM SSB/CW/FM transceiver

- Dual digital VFO's cover 430-440 MHz in 100-Hz, 1-kHz, 5-kHz, 25-kHz, or 1-MHz steps. Transmit frequency tuning for OSCAR operations.
- USB, LSB, CW, and FM modes. Facilitates 70 cm OSCAR operations.
- 6 memories, with back-up terminal.
- Automatic band scan of entire band or any 1-MHz segment, memory scan, and SSB, CW search of selected 10-kHz segment.
- HI—10 W, LO—1 W, power output.
- Other convenient features include noise blanker, RIT (SSB, CW) RF gain control, FM squelch, CW sidetone, and basic UP/DOWN mic.

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Specifications and prices are subject to change without notice or obligation.